Industrializing Secondary Schools in Tanzania through Scientific Innovations

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Abstract: *There has been a gap between the role played by universities and industries in improving the quality of science education in Tanzania as there is no established link between the three parties. The objective of this paper is to analyze the possible opportunities for industrializing secondary schools by up scaling scientific innovations using secondary schools, possible challenges and the way forward. The study has surveyed undergraduate students and instructors teaching and learning experiences at Sokoine University of Agriculture (SUA) and found out that very few industrial or outdoor practices are integrated with teaching. Also, University students' expectations are basically unrealistic as they are less informed about the way they will apply theoretical perspectives in the field of work. These observed experiences are rooted in schools where university instructors and students emanate. Through review of various innovations developed by universities including SUA, it was established that there are several innovations in different fields especially in crop cultivation, animal husbandry and natural resource management that can be introduced and then amplified in secondary schools as there are unutilized opportunities in such schools. It means, schools can be turned into industrial centers that can directly and indirectly benefit the community, production industries and more importantly improve the quality of science education at all levels as an engine for advancing development of science and technology. Though there are foreseen challenges in industrializing the schools, collective efforts of various stakeholders backed with political will can break through the challenges successfully.*

Key words: Secondary schools, universities, industries, innovations, curriculum

INTRODUCTION

Tanzania's Education and Training Policy URT (2014) advocates core values of entrepreneurship, independent thinking, creativity and hands-on skills which can only be cultivated in schools if the curricula advocate learning by doing. These values form the basis of the philosophy of education for self-reliance. However, what is currently practiced in schools does not seem to reflect the policy because there is no link between theory and practice. What goes on in most schools is that students study science concepts theoretically and there is no practical interpretation of the same in their daily life. This is contrary to research observation that students who

physically experiencescientific concepts understand them more deeply and score better on science tests (Hodgson and Pyle, 2010; Ingmire, 2015).

Therefore, the disconnection between theory and practice can be considered as one of the major reasons for the poor performance of students particularly in secondary schools in Tanzania. Though there are schools which run some income generating activities such as animal keeping, crops cultivation and small business, these activities are not run basically to support learning as they are not integrated with the school core curriculum. Also, such activities just operate on small scale with little or no tangible output. Low credibility of such activities can be associated with poor management skills or lack of the required expertise for managing such activities. Also, for such activities to have significant impact, students who are expected to form the required work force must have positive attitudes towards such activities. This follows research observation that negative attitudes can lead to low expectations of a person (Ali, 2009). It should also be noted that there is a strong relationship between the attitudes of students and those of their teachers as it has been established that a significant influence on students' classroom performance is teacher attitudes (Woodcock, 2013). This implies that when these students leave school and join universities they go with an illusion that learning science is all about theoretical perspectives.

So far it is not established how university students and instructors perceive the quality of their programmes with regard to their professionalism and if there are any opportunities for improving the quality of these programmes by forming linkages between industries and education institutions with science based programmes. Therefore, the objective of this study was to establish the link between the current practice, students and instructors' perceptions about the quality of their programmes at the university level on one hand and the quality of science education in the lower levels in Tanzania on the other hand so as to be able to explore the available opportunities and then make informed suggestions for the way forward.

METHODOLOGY

Research design

A survey research design was used in this study. Questionnaires were used so as to be able to survey a considerable number of instructors and students at Sokoine University of Agriculture which was the targeted population.

Sample size and sampling technique

The sample size in this study comprised 146 undergraduate students and 30 instructors from all faculties i.e. the faculty of science, agriculture, forest and veterinary medicine. Sokoine University of Agriculture (SUA) was selected because currently it is the only University in the country with the biggest number of students based in agriculture and agriculture related programmes as the purpose of the study was to explore the practices and perceptions of instructors and students with reference to the quality of the programmes and the means for improving them.

The researcher selected 36 students randomly from each of the three faculties i.e. faculty of science, forest and faculty of veterinary medicine. From the faculty of agriculture 38 students were selected randomly because this was the faculty with the biggest number of students doing agricultural programmes. Selection of students from each of the four faculties did not consider specific degree programmes but rather considered the year of study where more students were selected from the last year of study and least number from the first year.

Therefore; 8, 12 and 16 students were randomly selected from first, second and third year respectively from the faculty of science and forest. For the students in the faculty of agriculture the proportions of students were 8, 12, and 18 for first, second and third year respectively. For students from the program of veterinary medicine which run for five years, the proportions of students in the respective five years were 5, 6, 7, 8 and 10. For the case of instructors, 7 instructors were randomly selected from each of the faculty of science, forest and veterinary medicine; but 11 instructors were from the faculty of agriculture.

Data collection methods

The questionnaires were distributed among the selected instructors and undergraduates of the Sokoine University of Agriculture. The questionnaire items were consisted of closed questions because they were objective giving specific information. Closed questions were easy to administer, easily coded and analyzed to allow comparisons and quantification, and they were more likely to produce fully filled questionnaires while avoiding irrelevant responses.

Validity and reliability of the study

A pilot study was carried out before data collection in one degree programme different from the sampled one in order to determine validity and reliability. Information obtained from pilot study helped to identify

ambiguities in the questionnaires and modify them to reflect the objectives of the study. The pilot study was conducted twice at an interval of two weeks that used the same sample and instrument producing two sets of scores. These sets of scores were used to calculate reliability correlation coefficient which determined stability of the results over a period of time. The reliability coefficient was found to be 0.74 which is above 0.70; the value above which the data collection instrument is often considered sufficiently reliable to make decisions about individuals based on their observed scores (Erdvik and Haugen, 2015; Litwin, 1995).

Data analysis

The questionnaire responses were coded, edited, named and then items were entered into the Statistical Package for the Social Sciences (SPSS). Then all scores of instructors and students were converted to percentages in order to generate meaningful comparisons and facilitate the interpretation of results.

FINDINGS AND DISCUSSION

This section presents students and instructors perceptions about the quality of the programmes at Sokoine University of Agriculture that reflect the actual practice at the University and also at other levels of education. Based on these observations the author's discussion highlight the fate of science education in Tanzania but more importantly the available opportunities, expectations, challenges involved and the way forward.

Students and Instructors' Practice and Perceptions

Collected data show that university students never perceive the reality of their profession as related to the field of work. This is highlighted in Table 1 where when the students were asked if their expectations are fulfilled the responses were heterogeneous. For instance if percentages in the last raw are summed, the total is 95.8% instead of 100% showing that there were some students (4.2%) who could not state whether their academic expectations were fulfilled or not and others whose academic expectations were not fulfilled at all (34.9%). The same applies when they were supposed to give their views about the quality of teaching and their social life at the university.

Table 1: Undergraduates' Responses about Their Expectations before and After Joining the University (n = 146)

Expectation	Animal science		Aquaculture	
	Yes	*No*	*Yes*	*No*
Is your expectation prior to coming to the University still valid?	67(45.9)	10(6.8)	45(30.8)	17(11.6)
Has your expectation about the quality of university teaching been fulfilled?	37(25.3)	41(28.1)	36(24.7)	26(17.8)
Has your expectation about the quality of university teaching facilities been fulfilled?	24(16.4)	54(36.9)	26(17.8)	36(24.7)
Has your expectation about university social life been fulfilled?	53(36.3)	24(16.4)	42(28.8)	20(13.7)
Has your expectation about social life changed since you joined the University?	49(33.6)	27(18.5)	43(29.50)	19(13)
Has your academic expectation prior to coming to the University been fulfilled?	52(35.6)	25(17.1)	37(25.3)	26(17.8)

Source: Survey data at SUA (2016) (Values in the bracket represent percentages)

It means when students forecast on what they are going to do as professionals in the field of work they feel as if they are not properly trained. These observations demonstrate the disparity between university students' prior expectations and their actual university experience.

Unfortunately university instructors are derived from former students who went through similar curricula with very limited industrial or practical experiences; as a result the problem continues. Such experience was also observed by Adesoji and Olatunbosun (2008) that a student's attitude is related to teacher characteristics. For instance a survey of this study has established that, there was a considerable number of instructors who never integrate field experiences or experiences of the services they provide to the community in their teaching of undergraduate students (see Table 2).

Table 2: University Instructors' Responses on Their Ability to Integrate Various Outdoor Practices in Teaching (n = 30)

Aspects integrated with teaching	Degree of integration			
	Not at all	*Poorly*	*Well*	*Very well*
Laboratories integrated with teaching	6(20.0)	4(13.3)	11(36.7)	3(10.0)
Farms/production units integrated with teaching	12(40.0)	6(20.0)	5(16.7)	1(3.3)
Use of social Media integrated with teaching	7(23.3)	12(40.0)	6(20.0)	4(13.3)
Workshops usage in teaching	9(30.0)	6(20.0)	10(33.3)	5(16.7)
Case studies usage in teaching	4(13.3)	5(16.7)	19(63.3)	2(6.7)
Museums specimens/visits usage in teaching	0(0)	15(50)	7(23.3)	8(26.7)

Aspects integrated with teaching	**Degree of integration**			
	Not at all	***Poorly***	***Well***	***Very well***
Outdoor/Field expeditions usage in teaching	13(43.3)	7(23.3)	8(26.7)	2(6.7)
Industrial attachments usage in teaching	14(46.7)	8(26.7)	7(23.3)	1(3.3)
Community service usage in teaching	13(43.3)	11(36.7)	6(20.0)	0(0)

Source: Survey data at SUA (2016)

But these observations indicate that a considerable number of instructors could not see that there is a disparity between practical experience and theoretical perspectives they embrace in the classroom. For instance, less than 30% of the instructors are unsatisfied with the methods of teaching and assessment, philosophical outlook of the undergraduate programmes and the learning outcome (Table 3).

Table 3: Instructors' responses on the extent of their satisfaction with the programme Structure

	Degree of satisfaction		
Satisfied with:	***Dissatisfied***	***Satisfied***	***Highly satisfied***
Teaching and examination	7(23.3)	21(70)	2(6.7)
Content	7(23.3)	17(56.7)	6(20)
Methods of teaching and assessment	6(20)	21(70)	3(10)
Philosophical outlook of the undergraduate programs	9(30)	20(66.7)	1(3.3)
Description of learning outcomes	7(23.3)	18(60)	5(16.7)

Source: Survey data (2016)

This implies that most instructors consider their practice of implementing their programme curricular as satisfactory for their students to acquire quality, knowledge and skills required in the field of work. This is further justified by data in Table 4 where for example all the surveyed instructors indicated "agree" and "strongly agree" when they were asked if their programmes have up to date curricula.

Table 4: Instructors' perceptions about the quality of the programmes curricula

Instructors' views on the quality of the program Curricula	Degree of agreement		
	Disagree	*Agree*	*Strongly agree*
Programmes have up-to-date curricula	0(0)	24(80)	6(20)
Curriculum is well covered	5(20)	18(60)	6(20)
Curriculum is reviewed regularly	10(33.3)	15(50)	5(16.7)
Stakeholders are involved in curriculum review	10(33.3)	16(53.3)	4(13.3)
Guest lecturers improve curriculum contents	15(50)	11(36.7)	4(13.3)
Curriculum contains lists of important contents	2(6.7)	19(63.3)	9(30)
Gives a philosophical outlook of the program	6(20)	20(66.7)	4(13.3)
Describes clearly learning outcomes	2(6.7)	18(60)	10(33.3)
I pad/tablets are currently used by teachers and students	20(66.7)	10(33.3)	0(0)
Tele-conferencing facilities are available	27(90)	2(6.7)	1(3.3)

Source: Survey data (2016)

Also, Table 4 shows that 80% of the surveyed instructors "agree" and "strongly agree" that their programme curricula were well covered though more than 70% of the same instructors in Table 2 have already indicated that they "rarely" or "not at all" integrate outdoor activities or industrial experience with their teaching. This means even when poor methods are used to implement the curriculum it is considered "well covered" as long as instructors lecture in the classrooms.

The implication is that graduates from such instructors can never develop hands-on skills which are required in the field of work. This is one of the reasons why most of the university graduates in Tanzania fail to employ themselves. Probably, most of them are unemployable because they have not acquired the critical skills required by the labor market. For example, statistics in one study show that among East African countries; 52 per cent of Rwanda's graduates, 55 per cent of Burundi's, 63 per cent of Uganda's, 61 per cent of Tanzania's and 51 per cent of Kenya's university graduates are unemployable (Odoobo, 2014). Based on these data Tanzania seems to rank the second last among the five East African Countries in terms of employability of university graduates.

Opportunities

There are opportunities in secondary schools which can be utilized effectively to set the basis for integrating theory and practice when teaching

most of the science concepts. This is because there are several cotemporary innovations in agriculture, agribusiness, project and resource management, and environmental protection which are scientifically sound. These innovations can be introduced in secondary schools. Although attempts to introduce and disseminate, for instance, some of the agricultural innovations to local farmers have not succeeded considerably, it is because they are introduced in a form of funded projects which normally suffer extinction when the funders withdraw. Studies have shown that there are a number of factors that influence sustainability of projects. These are broadly categorized as planning and design, institutional, environmental, participation, government policies, donor policies, management and organization, financial, awareness and training, technology, social, gender and culture, economic, household and community resilience and structural change (Asian Development Bank, 2008; IFAD, 2009). Based on these studies, when the funders withdraw ability to support the farmers with education by applying the new technology against their cultural beliefs and practices become difficult. But the school context is different when compared with local farmers because in schools there is a cultural diversity of students and teachers, theoretical curricular perspectives support the new science and technology and easy access of schools by research scientists and industries. Furthermore, the schools are located in a wide range of different geographical locations that can support testing of various types of innovations. Therefore, if scientists introduce these innovations in secondary schools many problems facing local farmers will be addressed.

Expectations

Well established projects will substantially support the schools financially. This has been one of the reasons for establishing such projects in some African schools. For instance, in Kenya, the annual conference of secondary school heads held in Mombasa in 2013, asserted that some schools have initiated income generating projects and others are still planning to do so (Odundo and Rambo, 2013; Watima, 2013). The school heads who had started these activities stated that the income realized is mainly used for paying salaries for Parents Teachers Association (PTA) subordinate staff and maintaining the school bus.

These projects should serve as important centers for students to relate theory and practice for various subjects by also accommodating nearby schools, colleges and universities especially those which cannot run similar projects due to various reasons including limited space. Such schools can serve as models for executing the core curricular, co-curricular and extra-

curricular activities. This role was reinforced in Nigeria when similar school projects were being implemented by the government in May 2016 where the state commissioner for agriculture emphasized that development of both practical and commercial skills in agriculture need to be promoted with the aim of empowering students with cognate knowledge of agriculture to compliment the theoretical aspects taught within the walls of the classrooms (Ambode, 2016). Like their teachers, students in schools with outdoor projects are likely to be good entrepreneurs as observed by Education that pays for itself Charity group (2011) that teachers at a Self-Sufficient School have a credibility which teachers at regular schools do not have. Their students know that they not only have the knowledge to help them pass examinations but also the knowledge and experience needed to teach them how to make money.

Schools will later serve as research fields for all levels of education particularly universities, research institutions and production industries. For instance, Research Council of United Kingdom (RCUK) in March 2015 extended the funding to projects cementing School-University partnerships with similar aim of creating structured and strategic mechanisms for higher learning institutions to work in partnership with secondary schools and colleges. The partnership supports researchers' direct engagement with students and brings contemporary and inspirational research contexts into formal and informal learning to enhance and enrich the curriculum (RCUK, 2014).

There is evidence that when students are exposed to such partnership they develop skills for identifying avenues for new projects and possible funders. For example, in 2009 a group of students convinced Aalto University in Finland to grant €500,000 to establish Venture Garage, a hub for entrepreneurs and start-ups based on one of Aalto's main university campuses (Ernst and Young, 2012).

Another example of partnership is the one established by one of the largest universities in Australia, Charles Sturt University supporting the formation of Regional Collaborative Agricultural Networks that link schools, universities and industry. There has been an advantage in focused consolidation of expertise and networking across sites, with applied research facilities centered on universities and the department of primary industries as key suppliers of practical skills and training, with both supporting general and agricultural high schools within their regions (Charles Sturt University, 2014).

Challenges and the Way Forward

There are some foreseen challenges for industrializing secondary schools successfully in Tanzania because the idea needs to be perceived positively by all stakeholders especially school administrators at all levels starting from the ministerial level, teachers, students, parents and communities surrounding the schools. The physical infrastructure of the schools needs to be supportive as space; supply of electricity and water may be a limitation for the up scaling of the projects. Also, school project management skills are required so that the project and the core curricular activities can reinforce each other, instead of conflicting one another. This is the reason why Omukoba, Simatwa, and Ayodo (2011) observed that the main management challenges of school-based income generating activities in Kenya that one needs to deal with include lack of sufficient funding, land limitation, poor record management and lack of qualified personnel. Therefore, a holistic approach in industrializing secondary schools is mandatory for the projects to be successful with the government playing the central role to spearhead the idea. Although there is a greater possibility of the school based projects to sustain themselves once started, the initial momentum of their establishment may need injection of some capital not only for instituting the basic infrastructure but also for assessing and ranking the current status of schools and also training the necessary human resource for managing the projects.

Introducing innovations in Tanzanian secondary schools may take different forms such as improving already running small projects in some schools by value addition, establishing new projects where there are none, also expanding the existing ones. To start with, schools may begin by introducing simple activities as learning centers; a model which has proved successful in a good number of schools in South Africa. For instance, growing from 60 rural and peri-urban schools, 288 schools registered for the School Enterprise Challenge in South Africa in 2015. Students in these schools have set up school enterprises such as recycling waste, school snack shops and beaded jewelry making, generating profits of up to €448 in 3 months (Education that pays for itself Charity group, 2011). Then, the process of industrializing the schools may take place gradually by considering contemporary innovations in crop production such as orange-fleshed sweet potato, vitamin A maize, improved rice varieties, ready-to-use therapeutic foods, mobile phones use in agriculture, grain and seed storage, fertilizer deep placement, high-roofed greenhouses and (environmental friendly) pest management. Innovations in animal production may include, use of modern technology in animal nutrition,

breeding and reproduction, disease and health management, product safety and quality, integrating rice-and-fish farming and anaerobic digestion. The innovations need to go together with environmental management strategies of converting wastes to energy, practicing wastes sorting technology, improving soil fertility, conserving and recovering energy, rainwater harvesting and using farmers' knowledge in research and development.

CONCLUSION

This paper has highlighted a misalignment between theory and practice of science education in Tanzanian; a condition which leads to producing university graduates with limited knowledge and skills required by the job market. Based on what has been practiced in other countries the situation can be rectified by introducing scientific innovations in secondary schools in the form of production activities as a means of creating school-university-industry partnership that benefits each party. The most important outcome of such partnership is the improved quality of science education at all levels of education. But for this to be realized there must be a rigorous initiative of involving all education stakeholders in which the government should take the central role.

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