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ENGINEERING CURRICULUM CHANGES IN HIGHER AND TERTIARY EDUCATION: A CASE OF ONE POLYTECHNIC COLLEGE IN ZIMBABWE

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ABSTRACT

Whist there are abundant studies on the challenges of implementing curricular changes in schools, less information apparently appears to be available on the challenges of implementing the same in engineering at polytechnic colleges in Zimbabwe. To bridge this gap in knowledge, this study sought to analyze the challenges emanating from implementing curriculum changes in engineering at one polytechnic college in Zimbabwe. The aim was to determine how these challenges effected teaching and learning of engineering courses as well as suggesting strategies to enhance the same. The population in this study comprised of all the 107 lecturers in the department of engineering at Harare Polytechnic in Zimbabwe. The study employed the quantitative research methodology and adopted a descriptive survey design. It utilized stratified sampling to select a sample of 74 lecturers from the engineering department. The study utilized a questionnaire with both open-ended and closed-ended questions to gather data. The study revealed that the addition of non-core subjects in the engineering curriculum added more work to the detriment of the core subjects. Lack of lecturer consultation, resources and staff development were among the challenges cited as affecting the effectiveness of teaching and learning of the new engineering curriculum. The study recommends that there be stakeholder engagement and an evaluation of the impact of the intended engineering curriculum changes before their implementation to mitigate against the negative effects of such changes.

Keywords: Polytechnics, Curriculum Changes, Challenges, Higher and Tertiary Education

1. INTRODUCTION

The need to empower learners in schools, colleges, and universities with employable skills relevant to the 21st century has been part of the post-independence epoch in Zimbabwe from 2010 to date. Resultantly, the education system has gone through several significant changes. Whist there are abundant studies on the challenges of implementing curricular changes in schools, less information apparently appears to be available on the challenges of implementing

the same in engineering at polytechnic colleges in Zimbabwe. To bridge this gap in knowledge, this study sought to analyse the challenges emanating from implementing curriculum changes in engineering at one polytechnic college in Zimbabwe. The aim was to determine how these challenges effected teaching and learning of engineering courses as well as suggesting strategies to enhance teaching and learning of the same.

2. LITERATURE REVIEW

Hancock et al. (2012) define curriculum change as the transformation of the curriculum schemes, for example, its design, goals, and content. That is, it refers to the linkages or close working relationship between developers of syllabi, assessors of the syllabi (examination bodies), implementers of the syllabi (teachers), consumers of the syllabi (students), evaluators of implementation of the syllabi (school inspectors), consumers of the graduates (employers), and supporting education stakeholders (parents and community members). This implies making the curriculum changes distinctive in some way, to deliver it to a modern position or course. This often implies modification to its philosophy by way of its points and targets, checking on the substance included, revising its strategies, and re-thinking its assessment substance. For this to happen, curriculum changes should have clear and authoritative objectives that the targeted group and the society can easily understand. They ought to be multicultural and democratic through supplying all students with the aptitudes and information they will require in a global and differing society.

According to Dziwa et al. (2013), curriculum change is not a matter of supply of appropriate specialized data, but it includes changing attitudes, values, skills, and relationships. It requires expertise with drive to present and direct change. This means that the essential conditioning for change is the presence of structures, which can assist and speed up change. Hence, it is critical to note that there must be preparation to acknowledge these changes within the curriculum. Curriculum change implies changing a few of the fundamentals of the educational programs, which are content, techniques and assessment.

Since independence, Zimbabwe's educational system has gone through several significant changes, albeit these being at primary and secondary school levels. According to Nyirenda (2012), these changes have not been due to changing of different financial arrangements but due to the wishes of those in power. Resultantly, there has been a dramatic change within the instruction framework that influenced syllabus, reading material and many more. In schools in Zimbabwe, these are now competent based to ensure that students procure satisfactory aptitudes to be competent. The curriculum now relates to societal, industry and real-life circumstances. On the same note, the curriculum in colleges in Zimbabwe is no longer about scholastics but must bring a true understanding of students' lifestyle to upgrade technical and social meaning. According to Tooley (2012), determination of engineering courses is in consultation with the industry in order to ensure that students are able to progress into employment. This, according to Malone (2015) requires a shared cultural understanding of the higher educational program changes with the community.

Crossley and Mcnamara (2016) observe that support for technology for smooth and effective integration of new technologies remains a challenge. The challenges range from the procurement of equipment, the adaptation of curricular and teaching technique, incorporation of new educational tools, software training, technical, administrative and peer support as well as teacher attitudes, beliefs, and skills.

Malone (2015) highlights that curriculum reform is often perceived by the frontline stakeholders, teachers, students, families, and the community members as something done to them rather than something constructed with them. Thompson et al. (2018) note that there are continuously a few difficulties experienced by teachers amid the use of modern curriculum changes, especially when the newly presented concepts appear to be indeed new to them. These challenges incorporate teacher development and support, observing of the execution, evaluation and provision of educational material and other resources.

Aydin et al. (2017) argue that the most pronounced causes of curriculum changes in the United States of America are demographic changes on the curriculum and instruction provided in U.S schools, together with policy changes, emerging new technologies, globalization and the refugee and immigration issues. To them, schools must change structures, cultures, and programs of curriculum to meet the needs of students. They recommend that institutions of higher learning need to ensure that federal government, state leaders and school districts decide upon the appropriate reforms and changes to curriculum in school settings. In Kenya, Otunga and Nyandusi (2009) contend that curriculum reforms have been largely because of the cultural context since it compromises over 42 ethnic groups. Majhanovich and Geo-Jaja (2013) point out that The Ministry of Education in Kenya implements curriculum reforms, and these have been successful in making peace education compulsory. In addition to subjects already in existence, subjects like social studies in primary schools, religious education, history, and computers are additions to the curriculum as they deal with similar themes of peace building. However, Kinuthia (2009) noted that few teachers in Kenya were computer literate and even fewer could use a computer as a teaching resource.

2.1. THE ZIMBABWEAN CONTEXT

At independence in 1980, Zimbabwe inherited an education system modelled along the British system. For polytechnic engineering fields, it adopted the City and Guilds curricula, formerly reserved for the minority white, Asian, and mixed-race communities. The City and Guilds of the London Institute, the most important examination body for technical skills, stopped offering courses in Zimbabwe mid-1980 and actively assisted the Zimbabwean government to develop its own courses. The Higher Examination Council (HEXCO) – a body that administers higher education in Zimbabwean technical and polytechnic colleges administers these. To fund engineering trades, the Zimbabwe Manpower Development Fund (ZIMDEF) established in terms of the Manpower Planning, Development Act (28; 02) was set up and the Ministry of Higher and Tertiary Education, Science, and Technology administers it. Its objective is to finance highly skilled workers through a 1% training levy paid by registered companies in Zimbabwe. This gave rise to the introduction of the Zimbabwe National Craft Certificate (ZNCC).

The engineering courses offered through Hexco provide learners with skills and competencies necessary for gainful employment upon completion of a program. The curriculum emphasizes practical work and regards work experience as a crucial component of learners' experiences. Zimbabwe National Craft Certificate (ZNCC) programs required Higher and Tertiary Institutions to liaise with industry that offers formal employment to determine curricula vocation of the certificates. The assumption is that by involving industry, employers would recognize the vocational qualifications and be more willing to recruit college leavers for either employment or training. The curriculum changes have seen the introduction of a trade testing system that classified workers into skilled workers 4 to 1, class 1 being highest in

the artisan grade. Artisan training is through apprenticeship or direct entry into college. The aim of the curriculum is to produce artisans and technicians in engineering trades in areas like Automotive Engineering, Mechanical, Electrical, Fabrication, Civil Engineering, and Plastic Engineering. The curriculum changes have witnessed the introduction of four (4) levels of National Foundation Certificate (NFC), National Certificate (NC), National Diploma (ND), and Higher National Diploma (HND). This rationalization allows learners to move from an artisan grade National Certificate to a technologist grade Higher National Diploma (HND). Although Zimbabwean Polytechnics and other skills acquisition colleges like Universities, Private Colleges and Vocational Training Centers have embraced these curricula changes in Engineering, what is not clear is the impact of these curriculum changes on the effectiveness of teaching and learning of engineering courses.

2.2. THEORETICAL FRAMEWORK

The Concerns Based Adoption Theory (CBAM) informs this study. It is a change facilitation model that helps leaders and researchers comprehend, lead, and monitor the complex process of change in education Garrison (2021). The model works based on identifying various concerns in schools and is therefore ideal in providing an understanding of the impact of engineering curriculum changes in Zimbabwean Polytechnics. The model contends that before one can move to implement a new way of doing things, one has to address the questions people have about what the change means to them and their current practice Heejung (2014).

The model further contends that when individuals have higher concerns for a task or initiative, these receive their priority or attention Paramasveran and Nasri (2018). This suggests that people responsible for curriculum changes have to adapt to teachers' desires before rushing to adopt the new practices. According to the model, individuals progress through stages of concern as an innovation is implemented, moving from personal or self-concern about the task of adopting the innovation and, finally, to concern about the impact of the innovation Selwood, et al. (2012). The key feature of the model is to first address and resolve the concerns of persons seeking professional development and/or expected to take up specific tasks in the motivation. Kaiser et al. (2013) noted that all levels of concern involve attitudes, feelings, and motivation about implementing change.

The Concerns Based Adoption Model assumes that teachers have concerns that need to be addressed in order for them to achieve higher levels of curriculum change, during which process they may ignore, resist, adopt and adapt change, depending on the support given by the Ministry of Higher Education and other advisory boards like NAMACO. The concerns tend to fall under three categories, that is, self-concerns, task concerns and impact concerns. According to Hall and Hord (1987), several assumptions support the nature of change based on the Concerns Based Adoption Model. The model assumes that change is a process and not an event. It assumes that individuals accomplish change defined as a highly personal experience. Change involves developmental growth in feelings and skills. Interventions directed towards individuals, innovations and contexts involved facilitate change.

2.3. STATEMENT OF THE PROBLEM

Whist there are abundant studies on the challenges of implementing curricular changes in schools, less information apparently appears to be available on the challenges of implementing the same in engineering at polytechnic colleges in

Zimbabwe. To bridge this gap in knowledge, this study sought to analyse the challenges emanating from implementing curriculum changes in engineering at one polytechnic college in Zimbabwe. The aim was to determine how these challenges effected teaching and learning of engineering courses as well as suggesting strategies to enhance the same.

2.4. RESEARCH QUESTIONS

The following research questions guided the study:

- What are the challenges of implementing curriculum changes in the engineering department at your college?
- How have these challenges affected teaching and learning in the department?
- How can the college enhance the implementation of the curriculum changes in the engineering department?

2.5. SIGNIFICANCE OF THE STUDY

The study sought to analyse the challenges emanating from implementing curriculum changes in engineering at one polytechnic college in Zimbabwe to expose how these effected teaching and learning of engineering courses, as well as suggest strategies to overcome the same.

2.6. LIMITATIONS OF THE STUDY

The study is limited to the analysis of the challenges emanating from implementing curriculum changes in engineering at one polytechnic college in Harare, Zimbabwe, using the descriptive method which according to Anderson (2012) provides information that indicate norms not standards, and the investigator learns what is being done and not what could be done or should be done. The researcher using the descriptive survey determines usual practices, rather than causes reasons, meanings, or possibilities Kumar (2008). In view of the small population and sample size, the findings of the study might be difficult to generalize with accuracy.

2.7. DELIMITATION OF THE STUDY

The researchers delimited the study to the analysis of the challenges emanating from implementing curriculum changes in engineering at one polytechnic college in Harare, Zimbabwe using a sample of 74 lecturers.

3. METHODS

A quantitative research design focusing on an analysis of the challenges emanating from implementing curriculum changes in engineering at one polytechnic college in Zimbabwe. The purpose was to determine how these challenges effected teaching and learning of engineering courses, as well as to suggest strategies to enhance the same. The quantitative research design was useful because it makes use of statistics, which provides a lot of information Bell (2010). The study adopted a descriptive survey methodology, which according to Cohen and Manion (2011) allows for large-scale investigations and provides a lot more

information as far as value is concerned. However, one major weakness of this methodology is that numbers change often Leedy and Ormrod (2010).

The study's population comprised of all the 107 lecturers in the department of engineering at the Polytechnic College in Harare, Zimbabwe. The department consists of engineering disciplines Automotive, Mechanical, Electrical, and Civil Engineering. The study employed stratified sampling to arrive at a sample of 74 lecturers from the engineering department. This was because this technique permitted every lecturer in each of the disciplines of the department an equal opportunity of participating in the study Kumar (2008). The study utilised a questionnaire with both open-ended and closed-ended questions to gather data. This instrument allows the respondent time to consider questions and responses can be highly structured and easily coded. However, Anderson (2012) observes that the questionnaire attracts a low response rate if not administered face to face.

A request for permission to undertake the research from the Secretary of Higher and Tertiary Education in Zimbabwe and the principal of the college sailed through and so was the granting of the permission. Distribution of the questionnaires was when examinations were in progress during the period of October to December. Thus, the response rate was high because the respondents were present during this examination period. Respondents participated voluntarily and there was an assurance of their anonymity and confidentiality.

4. RESULTS

The study set out to analyse of the challenges emanating from implementing curriculum changes in engineering at one polytechnic college in Zimbabwe. The purpose was to determine how these challenges effected teaching and learning of engineering courses, as well as to suggest strategies to enhance the same. This next section is the presentation of results.

4.1. PRESENTATION OF DATA

Figure 1

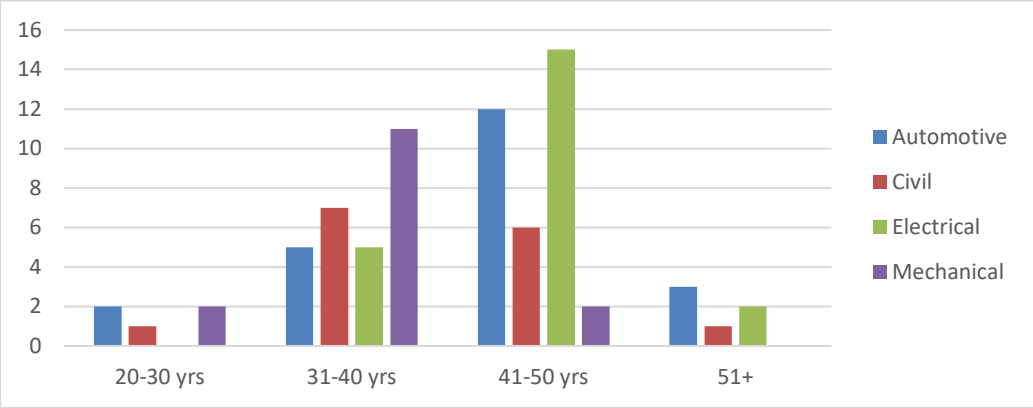

Figure 1 Distribution of Respondents by Age (N=74)

Figure 1 above shows that the ages of lecturers from automotive engineering follow a normal distribution curve. Civil engineering is dominant in the thirty-one to forty (31-40) age groups. The forty-one to fifty (41-50) age group dominates electrical engineering. Mechanical engineering is skewed to the left and prominent in the thirty-one to forty years (31-40) age group.

Figure 2

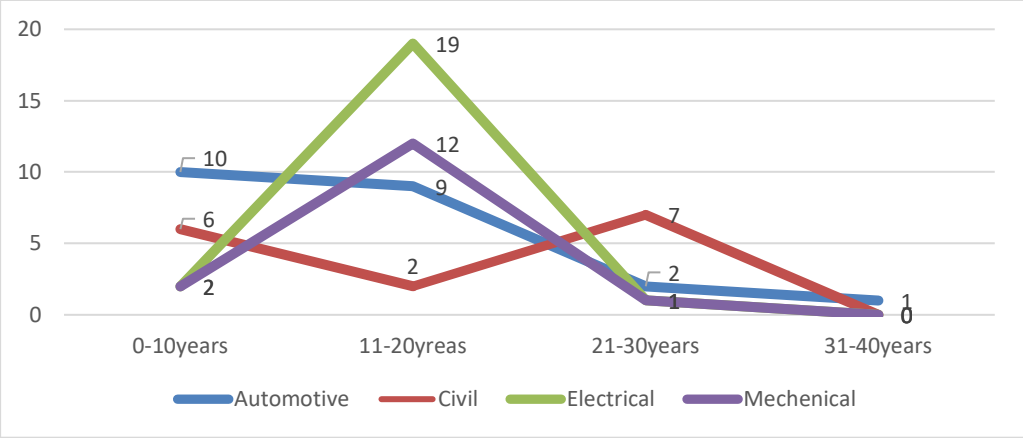

Figure 2 Distribution of Respondents by Experience in the Engineering Department (N=74)

The majority of respondents (56, 8%) had 11-20 years' experience. The 0-10 age range followed this at 24.3%, then the 21-30 age range at 13.5%. The least of the respondents (5, 4%) had 31-40 years' experience. Nevertheless, most of the respondents pointed out that they were not very qualified to teach additional subjects like NASS, Entrepreneurship and Computers. Most of them indicated that they did not have the skills to teach these subjects. Figure 2

Figure 3

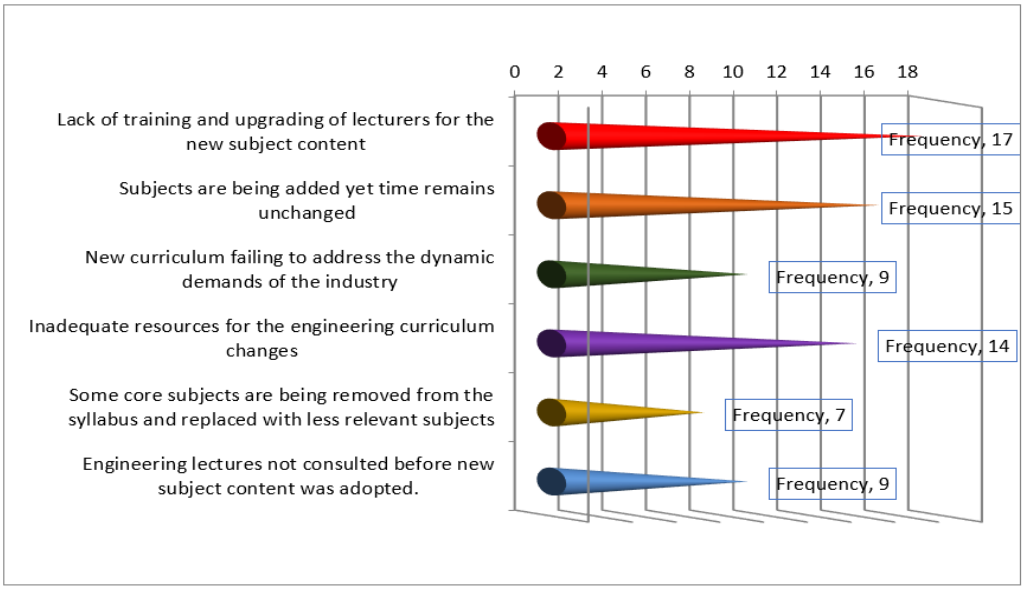

Figure 3 Responses on the Challenges Encountered When Implementing Curriculum Changes in the Engineering Department (N=74)

The respondents raised varied challenges encountered by lecturers in the Engineering divisions as shown on the Figure 3 above. Twelve coma two percent (12.2%) of the respondents cited lack of consultation before the adoption of the new content as a challenge. Twenty three percent (23%) of the respondents indicated that there was lack of training and upgrading of lecturers to the new subject content.

All respondents rejected the view that they received adequate training to implement the introduced curriculum changes. Twenty coma three percent (20.3%) of the respondents observed the addition of more subjects to the curriculum and yet the time for teaching and learning remained the same.

The majority of respondents revealed the impact of additional subjects such as National Strategic Studies (NASS), Entrepreneurship, Communication and Computers. They argued that additional subjects robbed core subjects of essential teaching and learning time. For example, prior to the curriculum changes in 2014, the allocated time for core subjects was 1576 hours. However, when additional subjects where introduced, the allocated time for the core subjects reduced to 1336 hours and 1250hrs in the Automotive and Mechanical departments respectively. The contact hours for core subjects reduced by fifteen coma two percent (15, 2%) and twenty coma three percent (20,3%) for Automotive and Mechanical engineering, respectively. Electrical, Civil, and other Engineering divisions had a similar deficit of hours.

Resultantly, the majority of respondents admitted rushing through the curriculum to finish it before the terminal examinations. Respondents also argued that though the regulations directed that the completion of the engineering syllabi be in two (2) years, those who came in through apprenticeship had to complete the same in one year. Twelve coma two percent (12.2%) of the respondents were of the view that the new curriculum was failing to address the dynamic demands of the industry. Eighteen coma nine percent (18.9%) of the respondents cited the challenge of inadequate resources for the engineering curriculum changes. In addition, they said lecturer-to-student ratio had increased and student enrolment had increased by more than one hundred percent (100%), resulting in lecturers combining or merging two or more classes putting unnecessary stress on the lecturers. Nine comma five percent (9.5%) of the respondents cited the challenge of some core subjects removed from the engineering modules and replaced by less relevant subjects.

4.1.1. RESPONSES ON HOW THE COLLEGE CAN ENHANCE THE IMPLEMENTATION OF THE CURRICULUM CHANGES IN THE ENGINEERING DEPARTMENT

All respondents emphasised the need for adequate training on any would be curriculum changes on the part of the lecturers in the engineering department. They revealed that the training or information they received was not even enough to cover all syllabi objectives of the additional courses introduced for them to teach the new subjects effectively. The respondents also suggested the need for the consultation of lecturers when their departments made curriculum changes. They found the top-down approach to curriculum change as detrimental to the implementation of the curriculum changes as the implementers resisted the change. The following were some of the suggestions given:

- There is a need to remove subjects that are irrelevant to engineering courses.
- More time is required for additional subjects.
- Training of lecturers and other staff on the implementation of the new curriculum changes to be done before implementation of new curriculum content.

- Lecturers and experts chosen for curriculum reviews should be competent and must have relevant engineering qualifications.
- There must be reintroduction of curriculum review programs in tertiary institutions.
- Availability of adequate training resources should be a priority.
- There is need to upgrade infrastructure to meet the needs of the new curriculum.

5. DISCUSSION

Results from this study indicate that respondents from automotive engineering had equal representation in all age groups, hence the reference to a normal distribution curve. Those from civil engineering were dominant in the thirty-one to forty (31-40) age groups. Those from electrical engineering dominated the forty-one to fifty (41-50) age group. Mechanical engineering was skewed to the left and prominent in the thirty-one to forty years (31-40) age group. These research findings reveal that most respondents were in the thirty-one to forty (31-40) and forty-one to fifty (41-50) age groups. This study can rely upon this age range's responses, as it is quite a mature age range.

Barring the 0-10 years' experience at 24.3%, the majority of the respondents (75.7%) were very experienced, and this implies that the information they provided was credible enough since they have been with the institution for a long time to understand what takes place there. The years of experience of the respondents were essential as they gave the researchers insightful and valuable information on the impact of curriculum change. They have experienced the difficulties that come with the change in curriculum. They have had a chance to teach in both the pre- and post-curriculum change periods.

Twelve coma two percent (12.2%) of the respondents felt that that they were not consulted when their departments made the curriculum changes. This implies that there was no buy-in from them. This is contrary to the Concerns Based Adoption Model (CBAM), which contends that before one can move to implement a new way of doing things, one has to address the questions people have about what the change means to them and their current practice Heejung (2014). This gives credence to Malone (2015)'s assertion that curriculum reform is often perceived by the frontline stakeholders, teachers, students, families, and the community members as something done to them rather than something constructed with them. Thompson (2018) note that there are continuously a few difficulties experienced by teachers amid the use of modern curriculum changes, especially when the newly presented concepts appear to be indeed new to them. In view of the finding and analysis given above, it suffices to conclude that engineering curriculum changes that lack lecturer buy in, and input lack the effectiveness they need to show, thus making no positive impact.

Twenty three percent (23%) of the respondents actually indicated that there was lack of training and upgrading of lecturers to the new subject content. All respondents rejected the view that they received adequate training to implement the introduced curriculum changes. The absence of training is an indication of the failure to first address and resolve the concerns of the respondents in this study. According to the Concerns Based Adoption Model (CBAM), individuals progress through stages of concern as an innovation is implemented, moving from personal or self-concern about the task of adopting the innovation and, finally, to concern about the impact of the innovation Selwood et al. (2012). Kyahurwa (2013). insists

that changes in education regarding curriculum at all levels require teachers to expand their knowledge and skills. The fact that the respondents cited lack of training and upgrading of lecturers for the new engineering curriculum content suggests that they may have received very little or no training on the new engineering curriculum changes. Thompson et al. (2018) implore that the greatest challenge facing curriculum reform is undoubtedly teacher training. Those people responsible for curriculum changes have to adapt to teachers' desires before rushing to adopt the new practices. Cetin (2016) observed that fifty-eight percent (58%) of teachers who undergo professional development sessions for technology develop increased confidence and positive outlooks about the integration process. This seems to imply that for successful curriculum change in engineering disciplines, lecturers must receive adequate training in the proposed changes before wholesome implementation. Engineering curriculum change can therefore not succeed in the absence of training before implementation.

Twenty coma three percent (20.3%) of the respondents observed the addition of more subjects to the curriculum and yet the time for teaching and learning remained the same. Nine comma five percent (9.5%) of the respondents cited the challenge of some core subjects removed from the engineering modules and replaced by what they consider to be less relevant subjects. The majority of respondents revealed the impact of additional subjects such as National Strategic Studies (NASS), Entrepreneurship, Communication and Computers. They cited a subject like National Strategic studies, which they consider to be woefully out of step with the true nature of engineering employability. They described how these additional subjects robbed core-engineering subjects of essential teaching and learning time. As a result, they admitted rushing through the engineering curriculum in an effort to accommodate the additional subjects before the terminal examinations. In the process, they failed to follow the regulations when it came to apprenticeship training. This challenge echoes what literature says, that many education reforms that restructure education systems with a market logic and managerial approach intensify teachers' responsibilities and in turn make teachers suffer from work overload and lack of leisure time Tsang (2014). Thus, increasing lecturer time load makes the impact of curriculum change less effective. Therefore, any engineering curriculum change effort that does not address lecturer workloads is doomed.

Twelve coma two percent (12.2%) of the respondents were of the view that the new engineering curriculum was failing to address the dynamic demands of the industry. This finding is despite the fact that literature says that determination of engineering courses should be in consultation with industry in order to ensure that students are able to progress into employment Tooley (2012). This finding appears point to a general disconnect between engineering lecturers and the market which absorbs their products. It is therefore important that engineering lecturers be familiar with the dynamic demands of industry to ensure a natural progression from college to direct employment on the part of the students.

Eighteen coma nine percent (18.9%) of the respondents cited the challenge of inadequate resources for the engineering curriculum changes. These finding echoes similar findings by Esau and Mpofu (2017), who found that the challenges that affected curriculum change included delivery time, lack of skills and knowledge, inadequacy of resources, parental expectations, and lack of clarity. However, Riley and Louis (2000) observe that a primary issue in implementing innovation is not necessarily the adequacy of financial resources but the availability of time and energy to support change.

The study proffers a raft of measures to enhance the implementation of curriculum changes in the engineering department. All respondents emphasised the need for adequate training on the implementation of the new engineering curriculum changes prior to implementation. The respondents also suggested the need for the consultation of lecturers when their departments made curriculum changes. Amongst the suggestions given were the need to remove subjects deemed irrelevant to engineering courses, availing of more time for additional subjects and upgrading engineering infrastructure. Perhaps a key recommendation as a way forward is to harness the provisions of the Concerns Based Adoption Model (CBAM) before implementing curriculum changes in the engineering department.

6. CONCLUSION

Presentation of the conclusion is in direct relationship to the study's aim; research questions and significance of the study and it represents the contribution to knowledge. Engineering curriculum changes that lack lecturer buy in and input as well as lecturer training prior to implementation lack the effectiveness they need to show, thus making no positive impact. Successful curriculums change in engineering disciplines therefore require that lecturers receive adequate training in the proposed changes before wholesome implementation. Engineering curriculum change can therefore not succeed in the absence of training before implementation. Similarly, increasing lecturer workload without addressing time load makes the impact of curriculum change less effective. It is important that engineering lecturers be familiar with the dynamic demands of industry to ensure a natural progression from college to direct employment on the part of the students. Engineering curriculum implementers are henceforth encouraged to harness the provisions of the Concerns Based Adoption Model (CBAM) before implementing curriculum changes. The study recommends that there be stakeholder engagement and an evaluation of the impact of the intended engineering curriculum changes before their implementation to mitigate against the negative effects of such changes.

CONFLICT OF INTERESTS

None.

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None.

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