ELECTRONICS FOR DESIGNERS COURSE: A CRITIQUE AND STUDENTS VOICES ON THEIR LEARNING EXPERIENCES

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Abstract
Electronics for Designers course is done by all Industrial Design and Technology students in year 3 of the five-year Bachelor of Design programmes. For those pre-service teachers holding a Diploma in Secondary Education (DSE) and Diploma in Technology Studies, the teaching and learning experience in Electronics for Designers course can be a daunting experience. Trainee students have to adjust to a new learning environment and experience complicated pedagogical theories and design philosophy, and this can be stressful. As a result, the failure rate in the course has previously been high. If this was not a core course some students would drop it as they lacked coping strategies and displayed lack of resilience. This study attempts to gain a deeper understanding of students learning experiences in undertaking the Electronics for Designers course and critiques the two Design and Technology 'O' Level syllabuses offered in Botswana and Swaziland. The study also maps graduate attributes that students gain through the course. The study used both qualitative and quantitative research approaches and is part of comprehensive action research to be conducted afterwards.

Keywords: design, problem-based learning, social constructivism, learner-centred, pedagogies, deeper learning

1.0 Introduction

The Department of Industrial Design and Technology in the Faculty of Engineering and Technology at the University of Botswana has over the years attracted students within Botswana and from other SADC countries to study for the Bachelor of Design programmes. Among these cohorts were pre-service students who are fresh secondary school leavers and in-service students with either the teaching or industry experience. The programme of study philosophy and rationale is learner-centred oriented pedagogies premised in Social Constructivist theories (Capel et al. 2009; Kukla, 2013). For those who pursue the Bachelor of Design (Design and Technology Education) the ultimate goal is to teach the Design and Technology syllabuses and curriculum at Secondary School level. As conscripted in one of the syllabuses, Design and Technology is a curriculum designed to produce literacy in design and related technologies. As a school subject it involves students designing in a practical context with a focus on, for example, food, textiles, resistant materials or digital media. The Cambridge IGCSE Design and Technology (D&T) syllabus in some SADC countries the department trains teachers for, states:

> '…Design and Technology enables learners to identify, consider and solve problems through creative thinking, planning and design, and by working with different media, materials and tools. As a result, learners gain greater technical and design awareness, while developing skills such as initiative, resourcefulness, enquiry and ingenuity. They also develop the communication skills central to design making and evaluation. Cambridge IGCSE Design and Technology provides an ideal basis for further study, and prepares learners for their future within a rapidly changing technological society' (CIE, 2015, p. 3).

This paper attempts to highlight some of the key pedagogical issues and students' perceptions about the Electronics for Designers course offered as a service subject to the Industrial Design and Technology students. The course is a one semester course offered by the Department of Electrical Engineering to third-year students, with some being direct entrants at this level. The aim of the course is to introduce students to basic analogue and digital electronics, with designing and analysis of digital circuits and amplifiers as some of the learning objectives. The perception of most students is that it is more engineering based and fails to provide for the opportunity to engage students in product design activities, hence the high failure rate every year. In 2007, an external review of the two Bachelor of Design programmes was performed and one of the concerns identified was the deficiencies of the service courses. These were found to be lacking in design approaches. As a result the aim of the Electronics for Designers course was reviewed to read as follows. The course seeks to 'familiarize students with the design and manufacture of Industrial and consumer electronic products being design students. The course also aims at equipping students with knowledge and skills of designing electronic products.' The course was designed to enable graduates to design and manufacture simple electronic systems.

2.0 Background

The Department of Industrial Design and Technology at the University offers 2 five-year Bachelor of Design (B. Des) Degree programmes: Bachelor of Design (Design and Technology Education) and Bachelor of Design (Industrial Design). As part of the teaching programmes there are several service courses sourced from other departments one of which is Electronics for Designers. All Industrial Design and Technology students in year 3 of the five-year Bachelor of Design programmes register for Electronics for Designers. For pre-service teachers holding a Diploma in Secondary Education (DSE) and Diploma in Technology Studies, the teaching and learning experience in Electronics for Designers course can be a daunting experience. Trainee students have to adjust to a new learning environment and experience complicated pedagogical theories and design philosophy, and this can be stressful. As a result, the failure rate in the course has previously been high. For instance, in 2011 27% of 33 students failed the course while 24% of 21 students failed the course in 2012. In 2013 and 2014 the failure rate was 13% (out of 52 students) and 15% (out of 30 students) respectively. If this was not a core course some students would drop it as they lacked coping strategies and displayed lack of resilience.

3.0 Purpose of study

Consultations with students and analysis of the end-of-year semester results showed explicit evidence that most of the Industrial Design and Technology students performed poorly in the Electronics for Designers course. This study therefore attempts to gain a deeper understanding of student learning experiences in the course and critiques the two Design and Technology 'O' Level syllabuses offered in

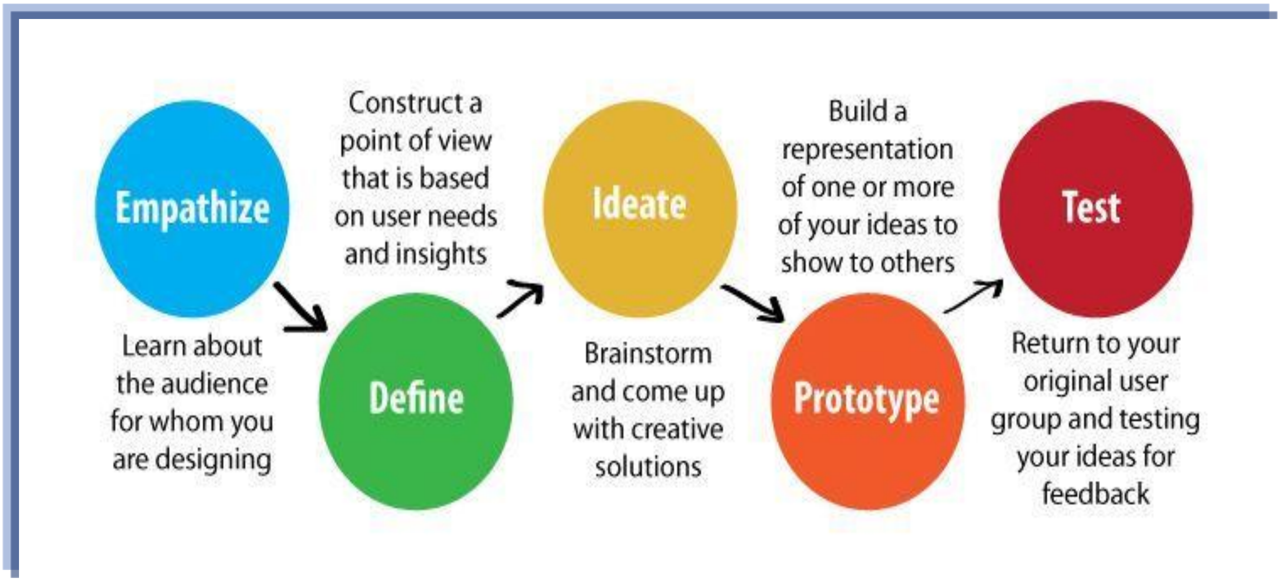
Botswana and Swaziland. The study also maps graduate attributes that students gain and have gained through the course. The study uses both qualitative and quantitative research approaches is part of comprehensive action research to be conducted afterwards.

4.0 Theoretical framework

4.1 *Design as a concept vs. electronics from engineering perspective*

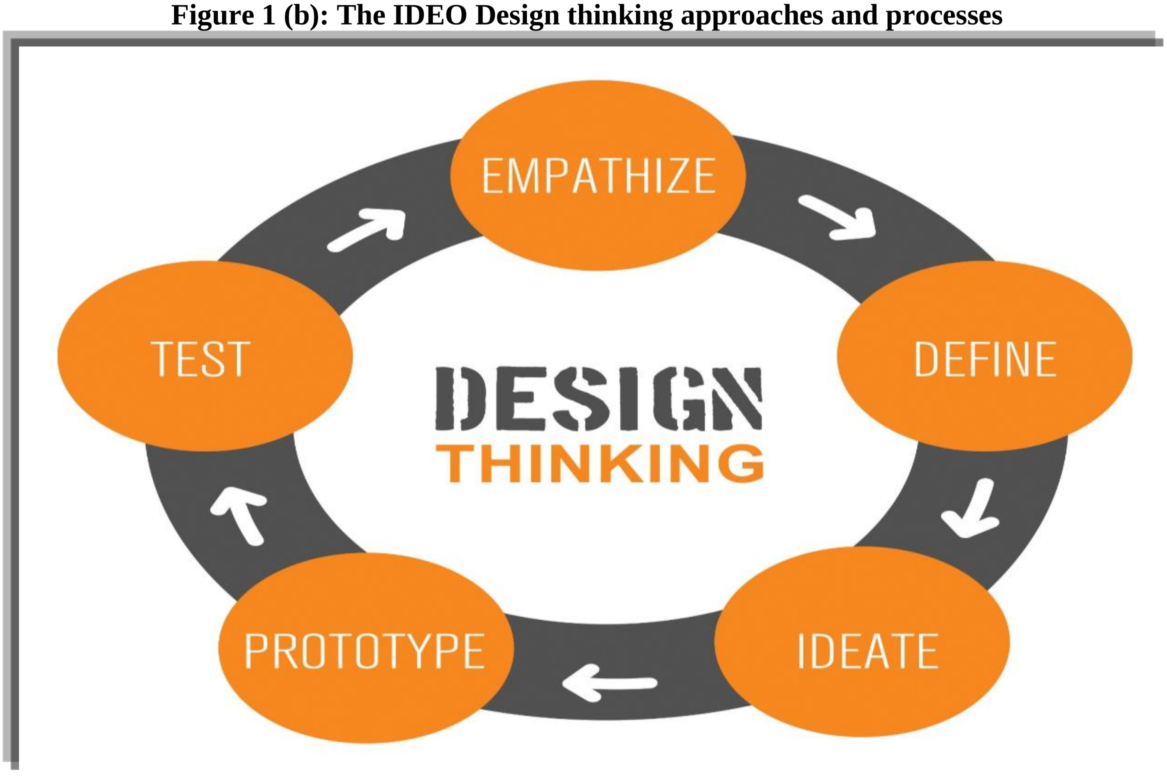
Design as a learning field is a problem-solving based subject. It is intuitive in nature and provides students with design thinking skills as well as theoretical knowledge. It is a process-based subject where students have to experiment with a range of materials. It has variegated knowledge, skills and attitudes, processes and is client-oriented where optimum solutions are provided to an identified need or opportunity. Through such design thinking processes students, ideate, prototype, manufacture, test and evaluate and execute a solution. From an engineering perspective, Electronics focuses on hard core engineering concepts where students have to work with a plethora of mathematical and scientific calculations. For example, logic operators, logic gates and logic functions, explaining the need for the logical codes and dealing with the Bipolar junction transistors. In most instances, there is a lot of simulations of solutions rather than practical engagement in an authentic real-life context. In design, students are supposed to apply design principles and concepts in a problem solving manner in producing electronic solutions. In such scenarios, the electronic components are used for a design product rather that students having to learn more about the chemistry of those components. It is in this premise that there is conflicting theories on how to teach Electronic for Designers from a design perspective. The way it is taught is more engineering inclined and students fail to apply these principles when confronted with real challenges. In executing electronic products and services, students are supposed to apply the design process as a vehicle and guide rather than an end product, while the electronics components and concepts are applied as an outcome of the need. In product design, students are compelled to follow the design thinking processes as exemplified by IDEO Design Thinking approaches: Empathise, Define, Ideate, Prototype and Test phases of the design processes in undertaking design tasks, inclusive of electronics product design. Empathy relates to understanding, observing and listening to the client without any preconceived preconceptions while Define is a stage based on evidence of observation and defining the design brief. Ideate is a stage where multiple ideas and concepts are formulated and generated to address a defined problem or situation. It is the exploration of possible alternatives. Prototyping focuses on trying out the best solution through informal research and through working models that are real to the idea. Testing is the evaluating stage performed against the design specifications. Figure 1 (a) and (b) schematically outline the IDEO Design thinking approaches and processes.

Figure 1 (a): The IDEO Design thinking approaches and processes



Source: IDEO Design Thinking Approaches

Figure 1 (b): The IDEO Design thinking approaches and processes



Source: IDEO Design Thinking Approaches

The five attributes of the Design Thinking process model as presented in Figure 1 (b) are as follows. **Empathy:** Design thinking starts with empathy and uses collaboration and participatory methods, repeating all five steps of the process as many times as needed to achieve a complete solution.

Define: Define the problem based on the evidence of the observations. **Ideate:** Generate many ideas (brainstorm) for potential solutions to the defined problem. **Prototype:** Research and build working examples of ideas. **Test:** Apply example prototype to original situations or problem. Part of this process requires students to demonstrate concept generation where concept selection capabilities are displayed and a range of working solutions are composed and created. The students use concept matrix; they look at concepts portability, suitability, aesthetics and manufacturing processes, for example. In product manufacturing, students factor in Design for Manufacture and Assembly principles where issues of sustainable environments are considered and the manner in which the product would be realised and packaged. In advocating for the problem solving in real-life context, Hill (1998) states, '… design processes are seen as creative, dynamic and iterative processes that engage explorations; join conceptual and procedural knowledge, both thought and action; and can encourage considerations to technology, human and environmental interactions' (Hill, 1998, p. 204). Hence design is a methodology underpinning any learning in design education, and has to be fully understood as it engages students in a pragmatic manner. Applying the methodology in the teaching of Electronics for Designers regards the process as enabling students to create, invent, modify their concepts using the matrix approaches and as observed by Hill (1998) builds knowledge making, not knowledge receiving. How lectures facilitate and deliver the content can be a dissuasive and thwarting activity that demoralises students learning. Gaotlhobogwe and Dube (2014) report that that low morale and dissatisfaction in learning among students may be attributed to mode of delivery and assessment practices.

4.2 *Teaching and learning theories*

Several teaching and learning theories and pedagogies are inherent to the successful attainment of graduate attributes in the field of design. Some of these are captured by Barth and Burandt (2013) and enunciated as the socio-constructivist perspectives that focus on the individual's learning environment. The Socio-constructivist Theories attest to the type of learning and teaching which is learner centred, enabling students to generate meanings out of the classroom learning experiences. Oluka and Opolot-Okurut (2014) opine that concluded that "classrooms as well as schools are important and that teacher and classroom variables account for more variance than school variables" (Oluka & Opolot-Okurut, 2014, p. 77). The core of the these learning theories are conscripted in the philosophy of nurturing requisite knowledge, skills, attitudes and values amongst learners, and prepares them for lifelong learning. Jollands and Parthasarathy (2013) debate the essence of Project Based Learning (PBL), in the affirmative viewpoint, which they found to be one of the most effective approaches to developing graduates attributes. They however, emphasized that these would depend on how PBL is implemented. They assert that PBL "is an educational approach to develop engineering graduate attributes" (Jollands & Parthasarathy, 2013, p. 5053). To that extent Tabulawa (1997) argues that several attempts have been made in institutions of learning to practice learner-centred approaches pedagogies in an attempt to deviate from the traditional teacher-centred authoritative instructional approaches. In reference to this observation Oluka and Opolot-Okurut (2014) highlight the features of teacher-based factors and note that the teacher is very influential in classroom instruction as the facilitator. Therefore, to improve learning outcomes and institutional responsiveness to quality learning most importantly depends on the teacher, teaching approaches and on inputs, i.e. resources and teaching and learning materials and curriculum packages, for example. This conclusion is also captured by Moumakwa and Monaka (2016) on referencing the Revised National Policy in Education (1994, p.2) advocacy for learner-centred approaches and affirmed, "…

teachers should be exposed to as many teaching methods as possible so as to provide a variety for the teacher and the learner with emphasis on a communicative approaches" (Moumakwa & Monaka, 2016, p.3). This statement captures fundamentals of learning and teaching in design which is leaner-centred and the design processes are perceived as the communicative approaches exhibiting students thought processes and execution of the solution.

Debating classroom transformations and curriculum transformation in subjects such as service subjects like Electronic for Designers, Msila (2009) argues for the Africanisation of education and the search for relevance and context. Therefore, in information delivery, student social construct and competences should be taken cognizance of before applying the scaffolding concepts where learning is structures and processes demarcated to allow for ease of understanding and conceptualisation. Chilisa et al., (2016), in regard to relational epistemology, argued that knowledge is a social construct and inevitably the modes of knowing form the basis of design of the methodologies.

According to the constructivist approaches which are sympathetic to learner-centred pedagogies, learner-centred teaching and learning is active and engages students; it is motivating; it promotes teamwork and learner collaboration and demands authentic real-life tasks to be undertaken by students and thus providing them with relevant learning experiences. The teacher provides clear and overt knowledge, skills, attitudes and values (KSAV), enabling students to think creatively and in a problem solving manner. In such experiences the mastery of content and desirable learning outcomes are achieved. Therefore, for any learning to be meaningful and fruitful students should be engaged and the focus should be on learners, with the teacher being a facilitator of the learning process.

5.0 Research questions and objectives

The current study seeks to answer the following research questions:

a) What are the perceptions of the students with regard to the course—the competence, body of knowledge and graduate attributes being acquired?
b) How appropriate is the 'O' level Design and Technology syllabus to be taught by the graduates of the course
c) What is the rationale and purpose of the Electronics for Designers Course
d) What are the challenges faced by students in studying the course (learning and teaching pedagogy, conflicting philosophies, nature of projects, and Interactive learning experiences)

Consequently, the objectives of the study are: To

a) establish the perceptions of the students with regard to the course—the competences, body of knowledge and graduate attributes being acquired.
b) critique the 'O' level Design and Technology syllabus to be taught by the graduates of the course
c) explore the rationale and purpose of the Electronics for Designers Course
d) identify challenges faced by students in studying the course (learning and teaching pedagogy, conflicting philosophies, nature of projects, and interactive learning experiences)

The interest in composing these research questions and objectives was to diagnose the type of interventions required for students taking the course and find insights into the revised Bachelor of Design programmes where electronics concepts are perceived and sufficed.

6.0 Methodology

A quantitative study was conducted through a survey, which was a probability survey with cluster sampling of the population (Burns & Bush, 1995). A survey is used to gather information from individuals through questionnaires, interviews, telephone conversations, e-mail, etc. To conduct surveys for large populations, a sampling method is required. Survey sampling describes the process of selecting a sample of elements from a target population. In cluster sampling, instead of selecting everyone in the population to give feedback, a sample population needs to be selected. The basic procedure for creating a cluster sample is to divide the full population into meaningful smaller groups and then randomly selects some clusters. The survey was conducted at the Department of Industrial Design and Technology (IDT), Faculty of Engineering and Technology, and the participants were year 3, year 4 and year 5 students who had already done the course. The study population was 106 students. For the survey sampling the total population was divided into study programs, the students were then clustered according to year of study, and then then subjects. The subjects were then chosen through a random process, and finally a census survey was conducted in those clusters. The study was predominantly quantitative in nature with some narratives for codifying the qualitative data.

The study was a purposive in nature (Saunders et al., 2009), with focus on the IDT students only as these are design students who have to employ the learnt concept form the Electronics for Designers course in the design projects in minor and final year projects. Feedback for this study was obtained from the sample population of 106 students using a questionnaire containing dichotomous type of questions. Random sampling (Creswell, 2015) was used to sample students across the three cohorts of classes of 2011, 2012 and 2013. Of the 106 students, 72 completed the self-administered questionnaire. Five focus group interviews with 6 students in each group from the class of 2014 and 2015 were conducted as part of the control principle to establish key emerging views and perceptions amongst students.

7.0 Results and discussions

7.1 *Strength and weakness of the Electronics for Designers course*

The entrance requirements set by the Department to the programme is BGCSE with a minimum of a C grade in Mathematics, D in English and C in Physics and Chemistry. Most of the students holding a Diploma in Secondary Education (DSE), Diploma in Technology Studies or BGCSE often find this course a challenge mostly because of poor mathematical skills. Students with background in common BSc Year 1 perform better in these courses.

The course content covers a combination of Digital Electronics and Analogue Electronics, and starts with the basics to a level where students are can do projects and are competent in the content such that they can teach. This broad content is usually covered within a semester. The Department offered Digital Electronics separately in a semester, and Analogue Electronics is also offered separately in a semester. Advance level courses are offered at higher levels. However, this Electronics for Designers course covers 7 weeks on Digital Electronics and 7 weeks on Analogue Electronics. Thus the time allocated for the course to cover broad content, particularly with the background that students have, is a challenge for the lecturer teaching the course. The lecturer is forced to spend a lot of time on tutorials and getting students to the level when they can begin to interact with the course content fairly well. It is because of this that the pass rate has started improving. There is dire need for the content to be unpacked and spread out over two semesters like is the case with Digital Electronics and Analogue Electronics mentioned above. This way the pace of information acquisition and learning would be more beneficial for the students.

A comparison between the current Electronics for Designers course and the D&T Secondary School syllabus shows that part of the course content has no direct link and does not build-up on content in the Secondary School syllabus. Further, some of the deficiencies in Electronics for Designers course syllabus are that it doesn't contain time delay circuits and capacitors. The extra material covered in the course is flip-flops. There is urgent need for the course to be to be aligned with Secondary School D&T teaching syllabus. The Electronics for Designers course content is structured such that if one grasps the material, they are in a position to design simple to complex systems using both digital and analogue electronics, and the students show great interest in the practical side of the course.

7.2 *Conflicting philosophies in teaching the course (host department vs. serviced department)*

The Electronics for Designers course is provided as a service course to the students reading for the degree in Bachelor of Design. The expectations and aspirations of the host Department and the serviced Department are conflicting. The serviced Department core methodology for the programme delivery is design driven with design processes forming the core of the pedagogical approaches, which is learner-centred. Most of the deliverables of the design courses are either product or service oriented. In the case of the servicing Department hosting the course, the teaching approaches employed are teacher-centred, thwarting the students' creative abilities as students are exposed to the classroom practices which them to regurgitate, memorise concepts and facts, and hence promoting surface learning where students reproduce what they have been taught. The outcome is students' inability to apply the principles of electronics and concepts in designing electronic products. The serviced Department promotes active and deeper learning by engaging students in product design, requiring them to solve real-life context issues and demonstrate their design thinking. This conflicting philosophy between Departments has resulted in poor acquisition of relevant competences and skills in electronics design and inability to relate what has been learned to the real world of work and to teach the content area effectively in Secondary Schools.

7.3 *Questionnaire responses*

Seventy two (72) students were sampled through random sampling and these responded to the administered questionnaires. Of these, 13% were females while 87% were males. Within the sampled participants, 42% were BGCSE holders (refreshers) and the remaining 58% were Diploma holders. The latter had teaching experience in Secondary Schools with some years of teaching Design and Technology. All the students took this course as a core course, compulsory for all of them. Some of the questions pertained to establishing student perceptions on content coverage, and breadth and depth of coverage.

Most students (61%) felt the content was adequate, and (54%) though coverage was fairly balanced. Consider Figure 2 and Figure 3.

Figure 2: Student perception about the adequacy of content coverage

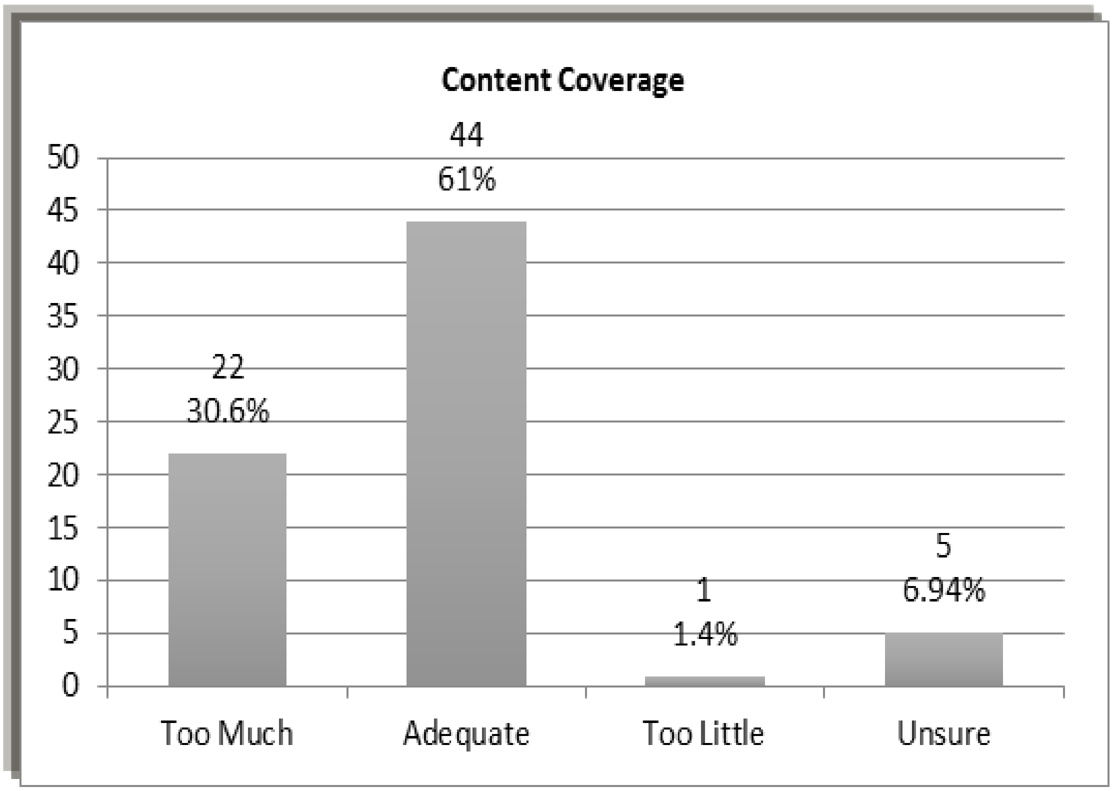
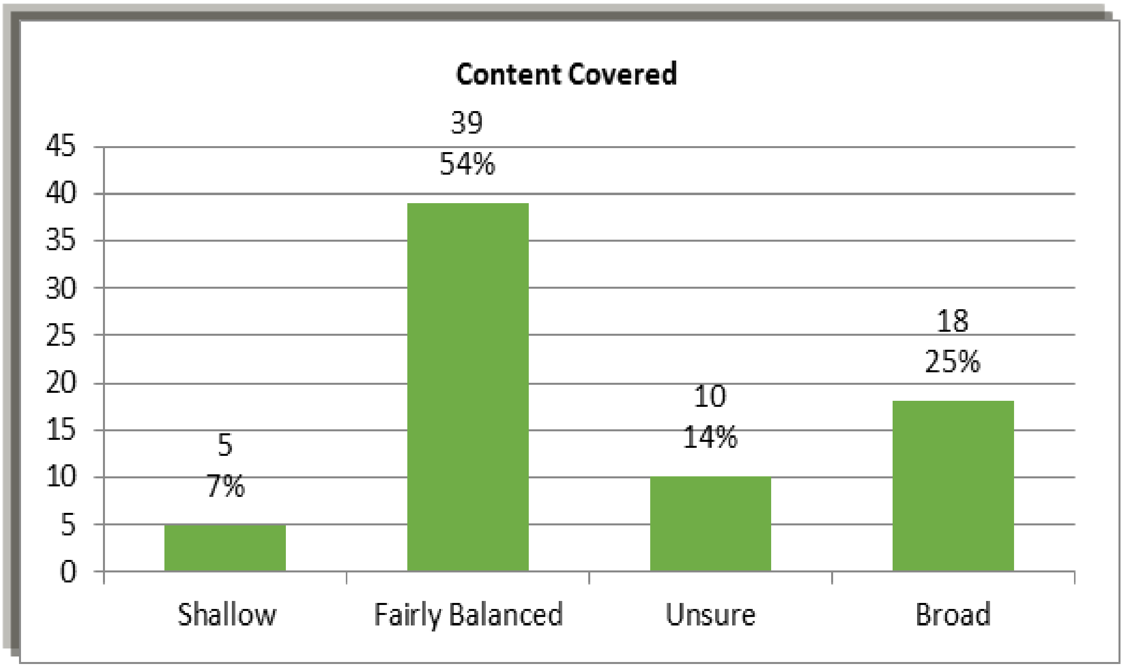
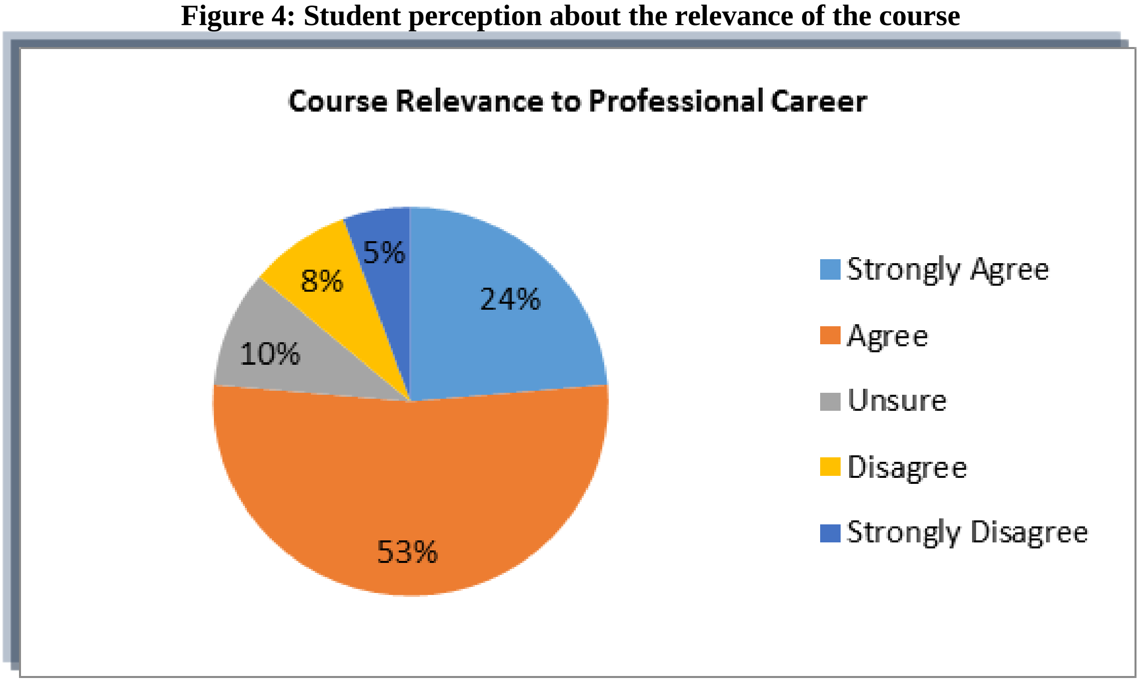


Figure 3: Student perception about the balance of content



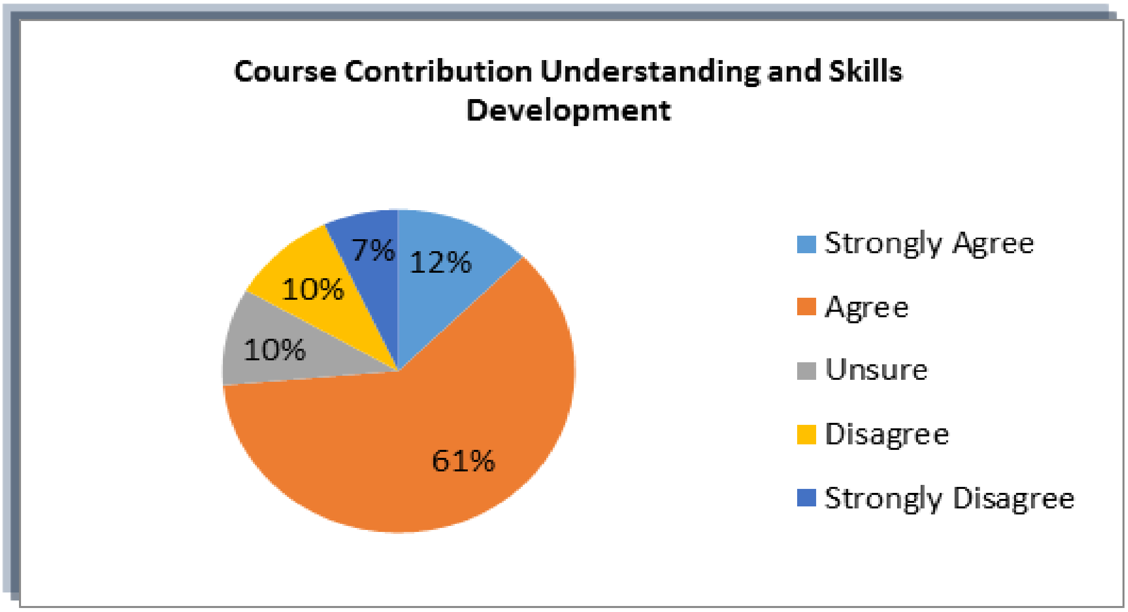
In terms of the course relevance to their profession as teachers and designers, 77% suggested it was relevant, 13% disagreed while 10% were unsure. Consider Figure 4.

Figure 4: Student perception about the relevance of the course



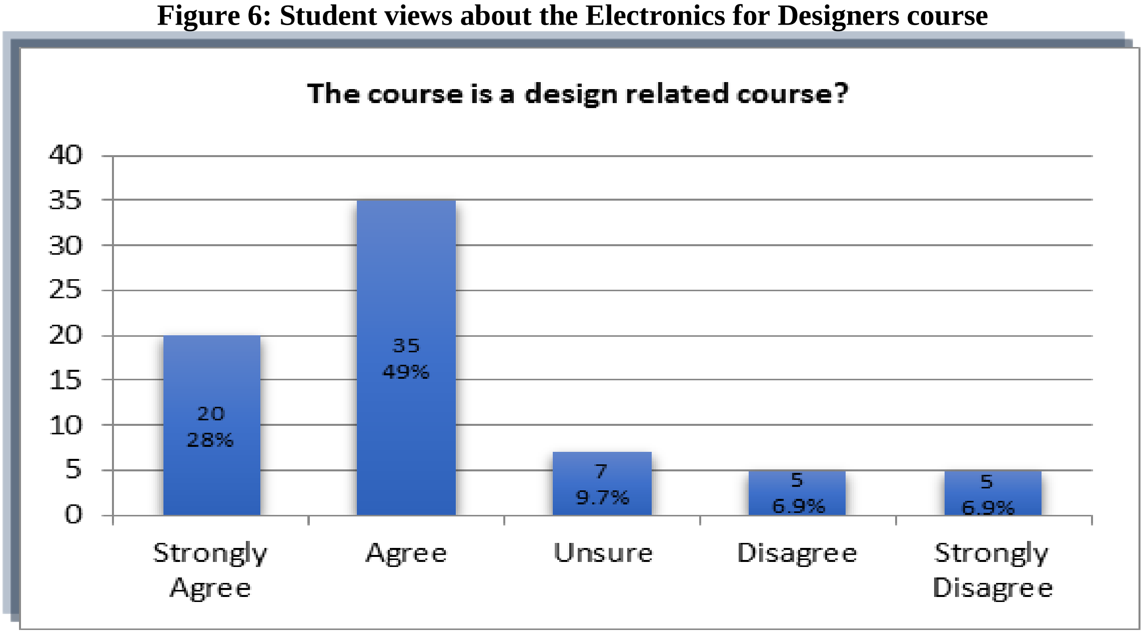
As to whether the course contributed to their understanding and skills development, 73% were on the affirmative side with 17% disagreeing and 10% unsure. The participants also felt that the course was design-related (77%) although more practical activities were suggested. Consider Figure 5

Figure 5: Student perception about knowledge and skills development



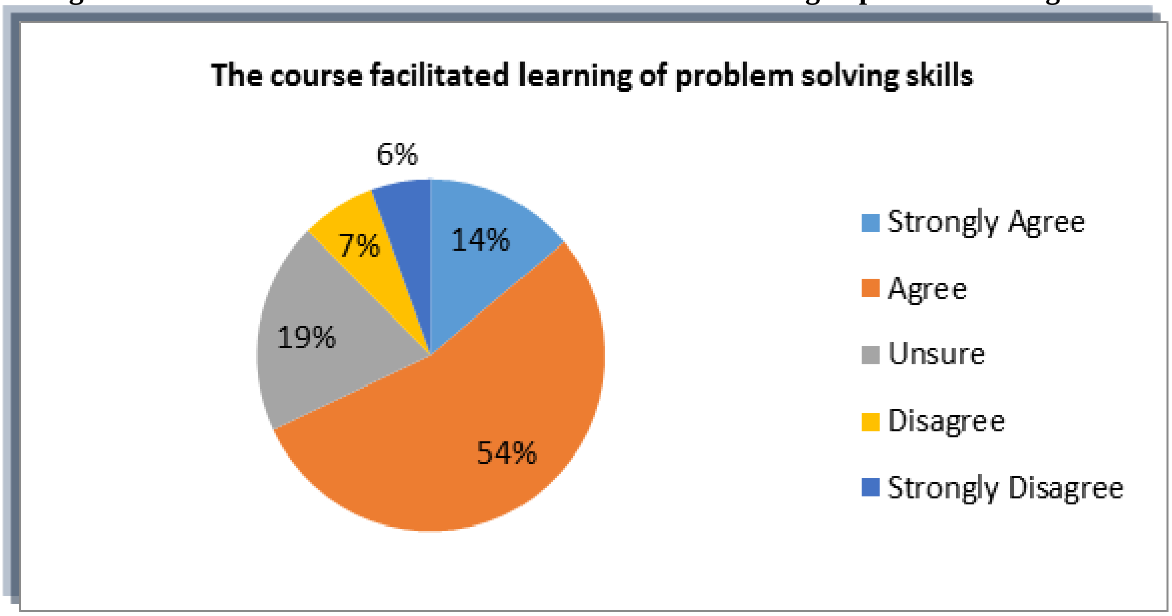
It is possible that failure rate could have been associated with student perceptions and not their field. The results however, negate this contention by suggesting that 77% of the students were of the view that the course is related to their professions while 9% were unsure and 13.8% disagreed. See Figure 6. The dissenting voices were of the view that there should be more classroom practice to develop their design competences in electronics design products.

Figure 6: Student views about the Electronics for Designers course



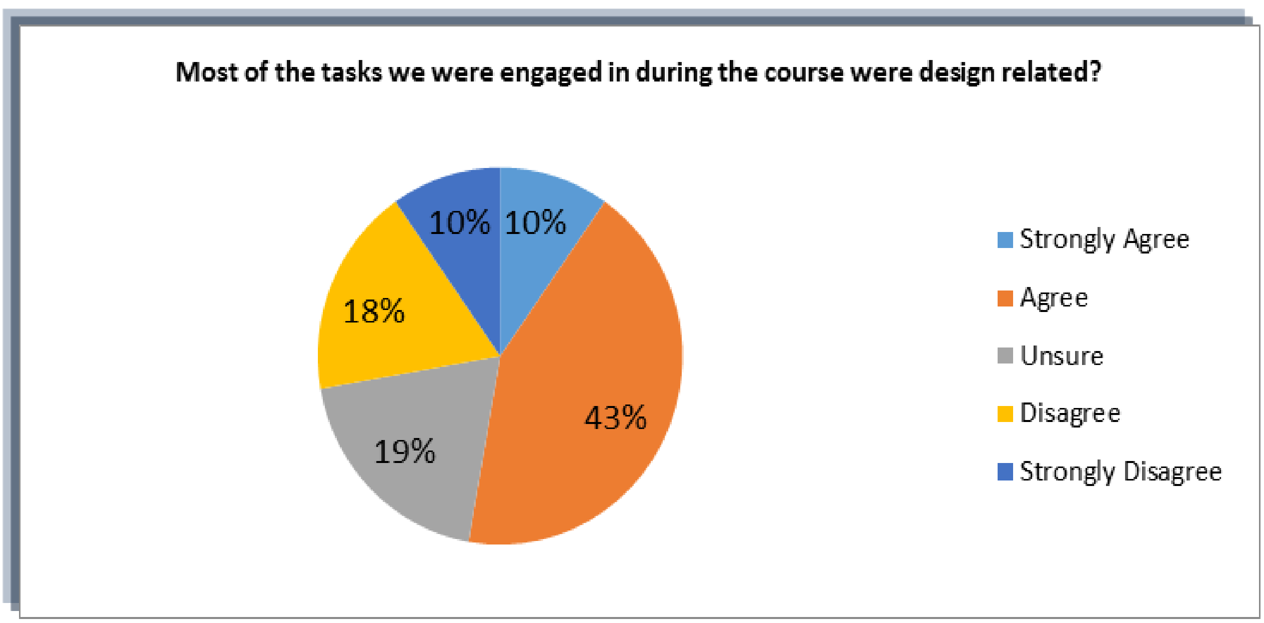
However, most students (68%) were of the view that the course facilitated learning of problem solving skills (Figure 7).

Figure 7: Student views on whether course facilitated learning of problem solving skills



As far as the classroom tasks were concerned, there was a fair division of opinion as only 53% were satisfied with the tasks as design inclined whereas 47% disaffirmed. Consider Figure 8.

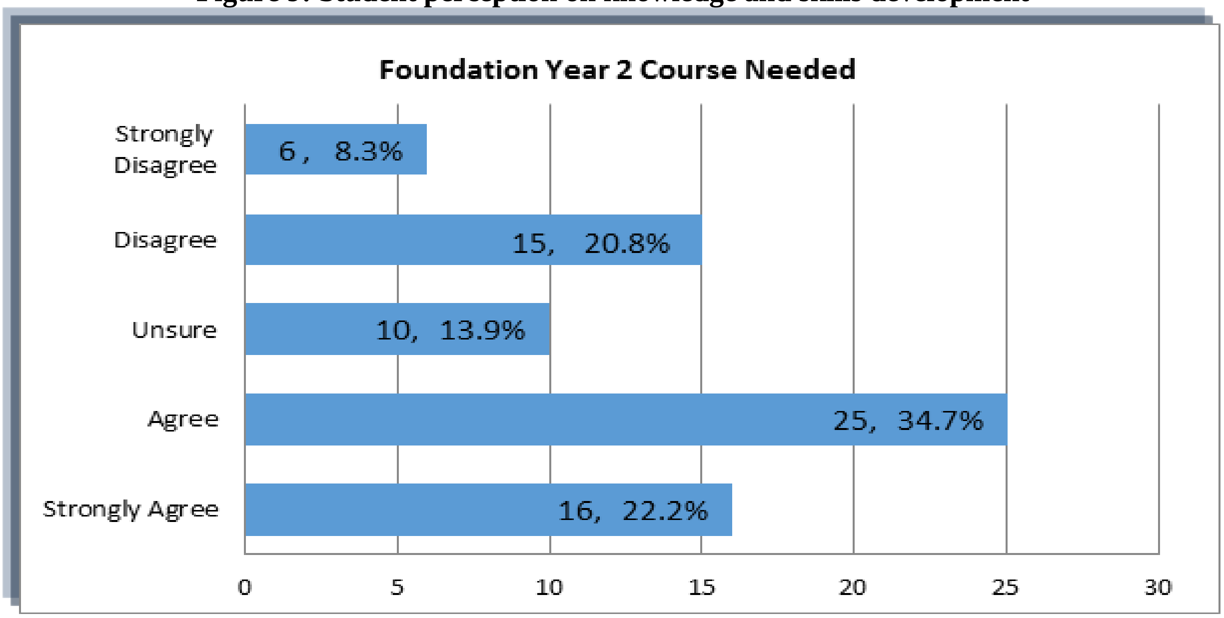
Figure 8: Student perception about the nature of the classroom tasks



One whether students required a foundation course in Year 2 before undertaking Electronics for Designers course, 56.9% felt they needed a foundation course while 32.7% refuted the proposition. See

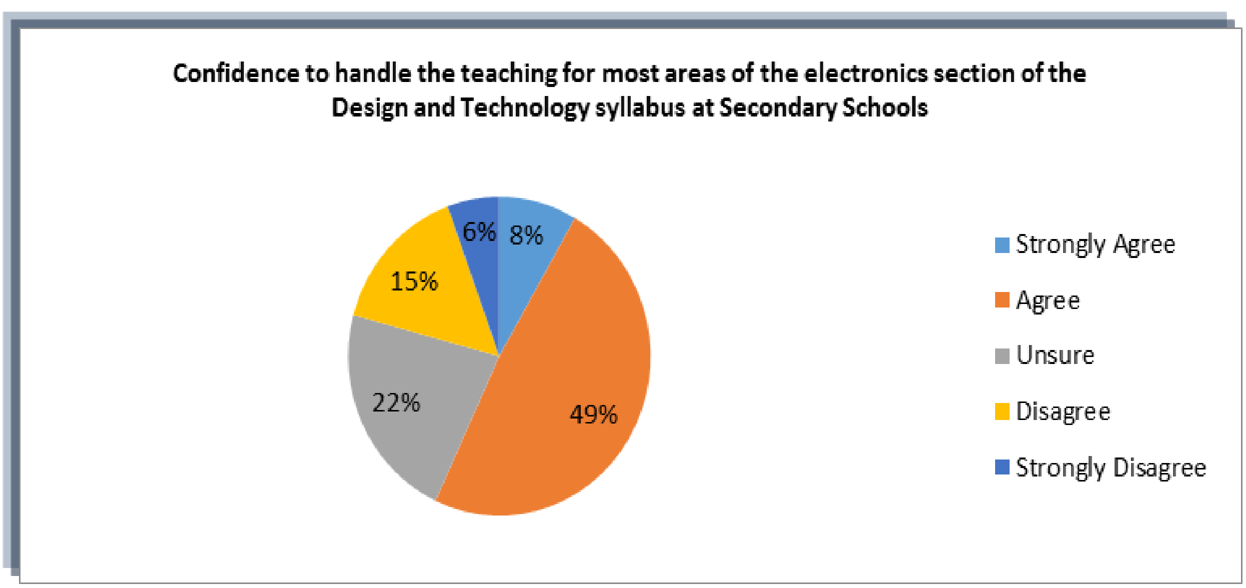
Figure 9. Moreover, in responding to the open ended question, most students (80%) were of the view that the course needs to be unpacked and the content spread over two semesters.

Figure 9: Student perception on knowledge and skills development



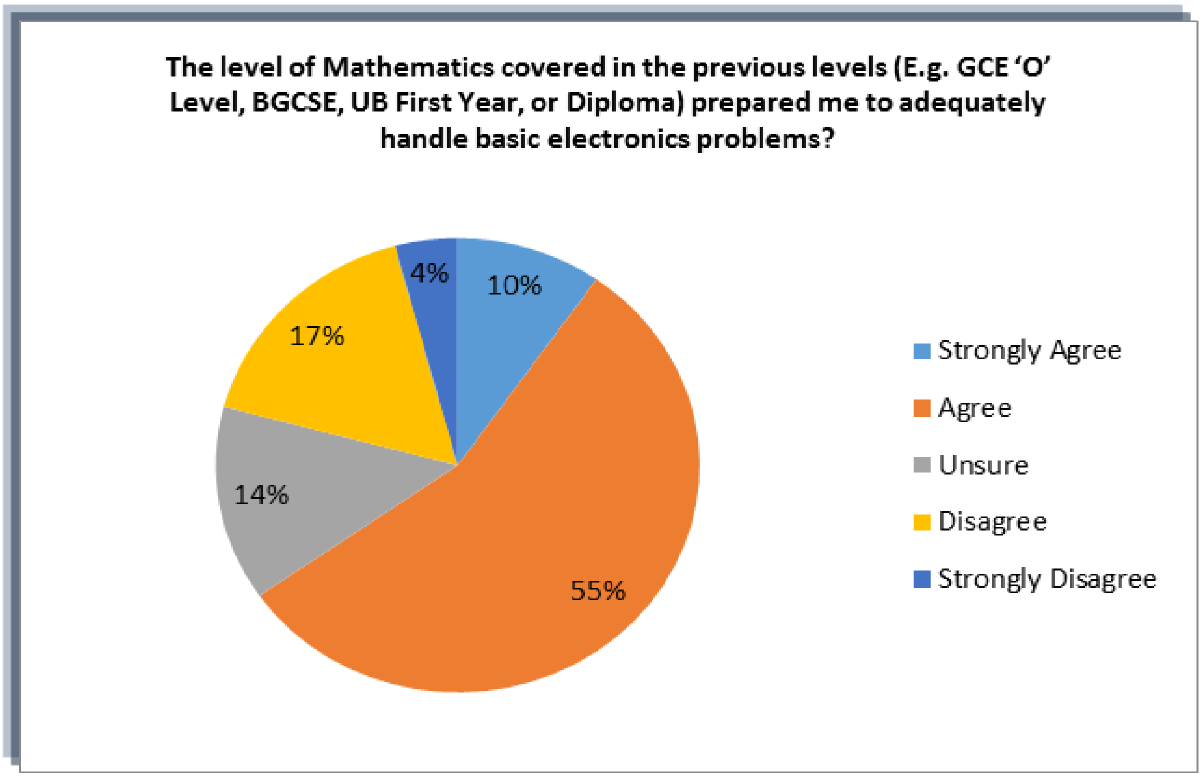
In relation to whether the experience gained from the course can be used to handle and teach Design and Technology syllabus in Secondary Schools, 57% were positive while 21% disagreed and the rest were not sure (Figure 10).

Figure 10: Students ability to teach Design and Technology Secondary School syllabus afterwards



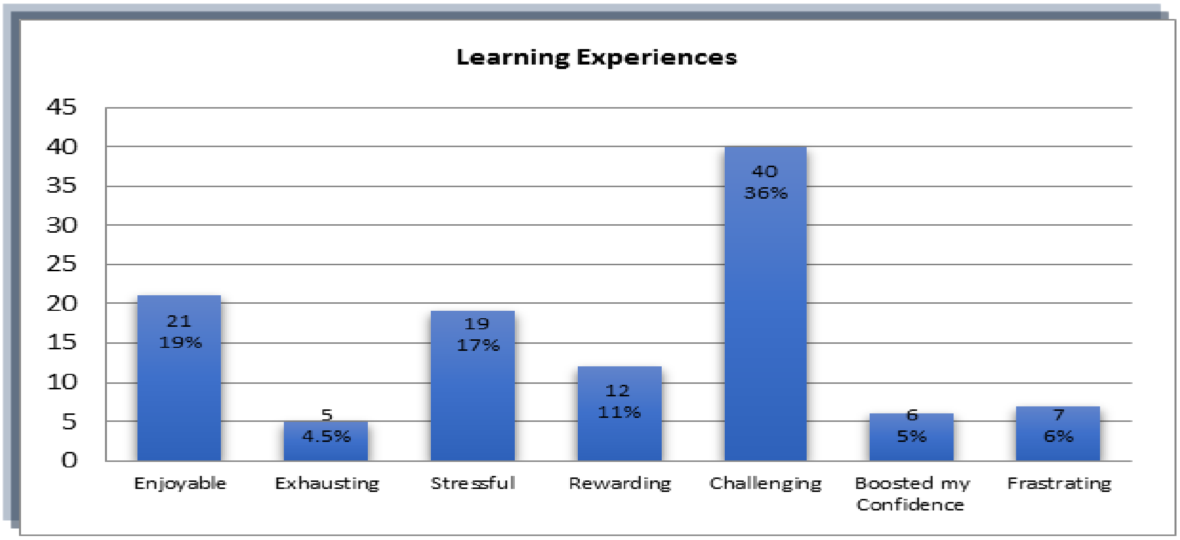
Sentiments about prior preparation of the students to tackle the course were expressed and 65% were of the view that the Mathematics learned at lower levels prepared them adequately for the course with 21% disagreeing (Cf. Figure 11). Out of the 21% disagreeing, the majority were the BGCSE holders.

Figure 11: Background preparation in Mathematics



Students were required to express their feelings about their learning experience in the course and the majority (63.5%) as had a negative image about the course, finding it to be stressful, challenging and/or frustrating, while only 35% had a positive view and enjoyed the course. Some sentiments expressed were that too much calculations and simulation were required in the tasks as opposed to application principles. Consider Figure 12.

Figure 12: Students learning experiences



The two memorable and enjoyable moments identified by students in the course were digital electronics and flip-flop design projects. In terms of the dislikes, students highlighted the following: too much content, doing both digital and analogue electronics in the same semester and the plethora of the abstract mathematical calculations. One of ten questions solicited students input for improvement. They were asked the following question: 'Given the chance, what would you suggest to be changed in the course to fully prepare you to handle the electronics component of the Design and Technology syllabus in Secondary Schools?' The following are some of the verbatim viewpoints:

'*The course should be done in stages'.*
'The course should focus on electronics that are in the JC Syllabus'
'More Analogue Electronics must be taught as that is what is taught at Secondary Schools'
'The course should be made practical–Only possible if course content reduced and group sizes reduced'.

Other comments of relevance were as follows:

'*Requests for more practical work and less theory'*
'Needs revision of maths etc.'
'Need for tutorials'
'Course should be done in 2 semesters'

7.4 *Focus group interviews responses*

Seven (7) open-ended semi-structured questions some with Likert scale responses were administered to the five focus groups. These focus groups were composed of 3rd and 4th year students who were not interviewed and not in the same cohort sampled for the questionnaire data sets. The questions sort to establish student satisfaction with the Electronics for Designers course, the support system provided with regard to learning and teaching, relevance of the course to the main programme of study and profession and student motivation level. Suggestions for improvement were also solicited from the students.

There were mixed feelings about the course from the respondents. Some suggested that the course was satisfactory while others were discontented. Those on affirmative noted that:

> *'The course was OK, even though some parts of the course were challenging, but overall it was fun'.*
> *The course is interesting and well organized'.*
> *'Very interesting. Taught principles designer required'.*
> *'Exciting and challenging'.*

The disgruntled voices commented as follows:

> *'This course has a lot of assignments which amount to 8 and as a result it has a lot of content unnecessary'.*
> *'The course has many assignments… But it did not give me skills in design because I never used the knowledge in any other design phases'.*
> *'I thought the course deals with electronic components that are needed in design product because it only deals with useless calculations that are not important in designing products'.*

As far as the support system provided in terms of learning and teaching, most students were happy although others felt that it did not provide application skills. They stated the following:

> *'The support is good but skills acquired cannot be applied to problem solving in design'.*

Most students perceive the course as relevant to their profession.

> *'I think it will help us during our major design project in solving other electrical related problems'.*
> *'The course can help students in minor and major project when designing products using electronics'*

Those who disagreed said:

> *'The course is not relevant to design and technology'.*
> *'Relevant but the thing is that it is not so practical i.e. no design practical aspect'.*

In terms of competence building and design technology capability development, there was a dichotomy. Two focus groups felt that with the experience gained from the Electronics for Designers course they can handle most areas of the electronics section of the Design and Technology syllabus at Secondary Schools. One group was not certain while the remaining two disagreed. In conscripting the 'strongly agree and agree' and 'disagree and strongly disagree', the students' responses indicated that their motivation towards the course was high. The students made the following suggestions for improvement of the course:

> *'Reduce assessment, too much many (8)'.*
> *'Remove digital electronics'.*
> *'Reduce course content and add more practicals and workshop activities'.*
> *'Because it is electronics for designers, we could be taught with practical objects'.*

The last interview question invited students to make any other comments.

> *'There was a lot that I learnt but in order for it to stick in my memory I need more exposure to the concepts through practice'.*

The only noted disadvantage was to do with the way the course was taught in terms of learning and teaching approaches as these were not in consonant with the 'design' and 'design and technology' pedagogies. The latter employ learner-centred, problem solving and project-based learning approaches. The design process in this case being the vehicle for learning and delivery of the design content. The deficiency depicted from the research evidence and 'the quantitative and qualitative data suggest that the course lacks practical exposure to design tasks and real-life context design activities. This creates a deficit in students design skills/competences in handling electronics design product, and practical application of systems and control concepts. The other noted points were the amount of assessment given which were taking too much fruitful time from students learning. The Electronics Products Design is client-oriented, underpinned by the design thinking processes as with the IDEO models, and engages students in practically following the constructivist learning theories.

The findings of this study contribute to the review of technology strands courses concerning electronics courses offerings. As a result, in the new revised Bachelor of Design programmes, there are both studio-based electronics courses and lecture-and workshop-based courses.

8.0 Implications for Theoretical Framework

The Theoretical Framework suggest that learning is effective when it is active and engaging and that design is a problem-based learning activity where students are tasked with real-context problems, situations or opportunities. In this dimension students have to be exposed to problem solving activities that provide them with the opportunity to recognise a need, analyse the need, research and define the need, conceptualise and conceive ideas and solutions to the perceived need or problem, produce a prototype or 2-dimensional/3-diemsnional model of the solution in a tangible manner that can communicate effectively to the client. In it is in this regard that students are requesting for more practicals in their course. The practical activities should be structured in such a way that it promotes incremental learning and depository of new body of knowledge and skills, hence practical competences would be achieved.

In regard to the teaching and learning theories, the students attest to these and corroborate with strong voice that these should provide opportunity for long-life learning as proven by the Theoretical Framework evidence. The learner-centred approaches that support the Design pedagogies and philosophy demonstrate that the practical design tasks and project work encapsulated in the teaching and learning of Design requires more workshop and laboratory practice. It also should be problem-solving based, employing problem-based learning approaches and pedagogy. As students and researchers posit these activities as supported by the Theoretical Framework, it would enable students to plan, think creatively, act, and plan the design electronic products and related activities in Electronics for Designers course with meaningful intention and purpose. Design processes in design are communicative tools and vehicles, illustrating the thought process used for effective learning in the subject area and these clearly lands themselves well to the fulfilment of the graduate attributes as spelt out by the university. Finally, the learning and teaching approaches required by the students, as well as content modification, should take on board the requirements of the Secondary School Design and Technology syllabuses that the students would teach in completion of the programme of study. Design thinking processes should underpin learning and teaching of the Electronics for Designers course.

9.0 Conclusion

This study explored students perceptions and learning experiences about the Electronics for Designers course offered at third-year level in the B. Des programmes of study. The primary purpose of this study was to explore issues faced by the students in learning the course and their adaption to it. The outcome of the study can assist in curriculum development and inspire further action research on the course and its relevance to the teaching of such components in Design and Technology syllabuses in Secondary Schools. Design is an experience-based subject where students are encouraged to develop design and thinking skills pertinent to product design and service design and the potential of solving real-life problems and situations. As enunciated in some of the Design and Technology syllabuses, the aims of the subject are to foster awareness, understanding and expertise in those areas of creative thinking which can be expressed and developed through investigation and research, planning, designing, making and evaluating, working with media, materials and tools; encourage the acquisition of a body of knowledge applicable to solving practical/technological problems operating through processes of analysis, synthesis and realisation; stimulate the development of a range of communication skills which are central to design, making and evaluation; and stimulate the development of a range of making skills. It is all about designing and making quality imaginative and functional prototypes, taking cognisance of the available body of knowledge and prerequisite graduate skills and attributes. As conscripted from CIE (2015) the knowledge, understanding and skills that all learners must develop are underpinned by technical principles and principles of designing and making. The pedagogies employed in the learning and teaching in design are learner-centred, with an iterative process providing the development of critical thinking skills. Therefore for any effective learning to be assumed, appropriate learning and teaching styles should be practiced and students should see the relevance of the courses of study.

This study disaffirmed and annulled perceptions that the Electronics for Designers service course offered to the Department of Industrial Design and Technology students provided a deficiency in students electronics design skills. The study also disaffirmed the conception that the students who undertook this course may not be able to effectively and with efficacy teach the design and Technology Electronics strand at the secondary school level.

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