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Concepts of Teaching and Learning

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Curriculum Critique

This section will provide for an academic critique of the curriculum design utilised within the context of the teaching experience environment. This will be compiled of the most pertinent information with respect to the design, content and delivery of the curriculum culminating in an identification of the flaws within its design.

Curriculum Overview

The teaching experience is composed of delivery of a 20-credit module entitled "*Object-Oriented Programming*" within an undergraduate degree course. The taught module resides at level 5 of the national academic scale as defined by the standards within the QAA. The standards for level 5 of this scale require that the student meet the defined criteria as follows:

- Knowledge and critical understanding of the well-established principles of the discipline.
- Ability to apply the concepts learned through tuition to other scenarios in the discipline.
- An understanding of the main methods of enquiry within the given discipline
- An understanding of the limits of the learners knowledge

[12]

Suggestions are provisioned for the content of the module, however, is largely directed at the discretion of the tutor affording creative freedom for the inclusion or exclusion of topic areas. This flexibility allows for the tutor to tailor content and delivery of said content within the curriculum to the dynamic of the group affording better adaptations to the learning styles of the individual [3], [2].

The environment in which tuition is to take place is represented by a typical computer laboratory where students are provisioned appropriate computational tools to service the creation and sharing of ideas built upon the concepts explored. This ensures that the students are located within an appropriate environment for adequate practice of the concepts explored within the sessions, evidencing the higher order thinking skills utilised [4], [13].

Structural Design

The composition of each module within the consists of 60 hours of tutor contact in which lead lectures and directed tutorials are provided and complemented by the inclusion of 140 hours of student directed learning. The use of this approach follows the ideas proposed by Knowles in his elicitation of andragogy in place of the more traditional pedagogical approaches to teaching [1].

The allocated teaching hours throughout the curriculum have been divided evenly over an academic year consisting of two contact hours for every session during the teaching weeks. The design of modules in this way provided for a sustained level of contact and consequently monitoring of the progress made by the students throughout their study. This approach further cements the ideas as proposed within the realms of the cognitive and humanistic approaches to learning [17], [16], [14], [15].

The assessment components found within each of the modules in the curriculum are stipulated to be submitted in various forms of summative and formative assessments. For example the software development module includes a primary assessment element to be submitted as a formative written research paper and a further summative exam. Most assessments are equally weighted each carrying half the total marks for the modules.

Curriculum Aims and Learning Outcomes

The curriculum incorporates the use of both theoretical concepts and the demonstration of practical elements throughout the course of study. The students are expected, upon the outcome, to be able to demonstrate their skills in the use of design aspects and the implementation of software elements from the instructional materials. The wording utilised for all aims and learning outcomes are appropriate in terms of the level of education, however, some fall short of the academic clarity required in terms of the terminology in what the students are being asked to achieve.

Curriculum Model

For the most part this course of study adheres to the less traditional process model [18] in that it utilises a relatively student-centred approach to learning in which the student drives their own learning. Such an approach is further supported by the heavily biased self-directed learning element of the study identified within the curriculum design.

Other aspects of this curriculum follow the more commonly tested product model [19] along with the incorporation rigid testing mechanisms in the form of summative assessment upon the culmination of the study. The use of the product model is tempered somewhat by the use of a formative assessment manifest in a qualitative literature element, to ensure deeper understanding of the ideas being proposed, softening the behaviourism driven ideologies of the product model [20].

Critique

Though there are many positive elements to the curriculum for the given module there are also several detrimental impacting factors resulting from the stated curriculum.

Following the ethos behind adult learning within higher education, this curriculum exhibits a large amount of flexibility with respect to the inclusion of content. This flexibility, although in many cases beneficial to the progression of the learner, does pose some problems regarding interpretation and subjective bias or emphasis on topic areas that the tutor may be more familiar with. The interests of the tutor can exhibit a large impact over the taught elements of delivery creating cases where the student may be taught outdated or irrelevant information [21]. If the tutor were to consider the areas which would yield the greatest interest and engagement from the students this would venture into the realms of humanism. This is particularly pertinent when considering the works of Dewey [22], [23] and Rogers [24] the impact of relevance and experiential learning.

The vast majority of modules are cohesive and provide for a seamless transition between content areas however, there are modules that deviate from this trend. With respect to the inclusion of the software module within the overarching curriculum, there exists an issue pertaining to the disparity of the content to that of the other modules it runs in parallel to. The major focus on the software

development element here is a little ill-placed within the confines of the course and provides a view that the structure is marginally disjointed in nature causing confusion and uncertainty as to the relevance [25].

The indicative content specified for the software module is limited in its elucidation of those topics that are to be covered. Though the point has been made that this is suggested content for delivery, the fact remains that such pre-variance makes it far more difficult for a student to follow the natural path of learning throughout [26], [27]. This in turn makes it far harder for the tutor to provide a standardised approach to the learning that could be repeated consistently.

The field of software-engineering provides a veil that exhibits a false sense of objective thinking with respect to the concepts outlined. Though the core elements of the discipline are inherently objective, the same concepts hold the unique ability to be applied in a multitude of differing ways to achieve the same task. This is contradictory to the semantics supposed by the module descriptors learning outcomes whereby it is presumed a behaviourist [28] approach will be observed. A much more appropriate philosophy here would be the adaptation of the cognitivist approach [29].

Conclusion

The teaching practice undertaken incorporates the use of many curriculum philosophies. The formative assessments provide for an appropriate means of demonstrating the ability to use the more practical skills covered in the tuition sessions, whereas the summative assessment could lead to confusion and uncertainty among the students when performing revision contradictory to the works of Gibbs [30].

Curriculum Proposal

Curriculum Title

This document outlines a course of study for undergraduate level students. The content herein is concerned with delivery of materials for the course entitled *BEng Computer Systems and Electronics*

Curriculum Description

The learning program will incorporate an amalgamation of both delivered elements and independent study to further the knowledge of the student within the discipline of software. This module is a component of an overarching undergraduate degree for electronics engineers.

Taught elements will be manifest in the form of tutor lead lectures and tutorial sessions. Lead lectures will consist of delivery of new theoretical concepts and ideas. Tutorial sessions will provide the practical setting in which students will employ the use of skills covered within lectures, affording opportunity to refine such skills. The inclusion of both analysis and design tasks will permit the opportunity to extend the students basic understanding of the ideas proposed and further this through independent exploration. A considerable amount of responsibility is placed upon the student, encouraging autonomy and self-directed learning based upon essential and recommended literary works for the discipline. The delivered material is constrained by the level at which it is taught adhering to those principles outlined for study by the QAA [12].

More emphasis will be placed upon the practical elements of the study as a consequence of the nature of the skills to be obtained. In many respects the translation of skills from theory to practice makes the learning process far easier to assess particularly when utilising a formative assessment approach. In the case of both electronics and software it is difficult to assess the ideas proposed without practical demonstration of said skills. Formative assessments related to electronics could manifest in the form of circuit design and creation whereas learning within the software domain could be evidence through the production of working programs.

Target Student Demographic

The target student group for this curriculum will be those individuals situated upon the second year of an undergraduate degree program. The intent of the overarching program is the delivery of an undergraduate degree tailored toward electronics engineering. As part of this course of study, the students are to cover a number of differing concepts; included within this is the theme of digital electronic components and circuits. Electronic components and circuits, especially those that reside within the digital domain, require control logic that must be actuated with greater accuracy and frequency than is possible through manual intervention. It is in this instance that the role of software within the study programme becomes far more apparent.

The inclusion of this element within the programme, provides for greater understanding of the finer details of the digital components utilised within projects and provides headway into other fields inclusive of digital signal processing and software development. The links between the implementation of both hardware and software elements will be highlighted with respect to their applicability to the pathway into the discipline concerned.

The background of prospective students for the electronics engineering course will typically consist of attainment up to and including level 3 of the national academic scale, with students having studied physics at this level. Individuals without this background are to be considered based upon prior experience within the industry for example those undertaking study as part of their employment within the sector of electronics engineering. Prospective industrial partners could include the likes of Sony, Panasonic and Hoover.

Learning Objectives

The specific learning outcomes of the program provide for a means of effectively and holistically delivering content in a manner that facilitates learning that best suits the subject. In progressing towards this goal, the learning outcomes for the blended disciplines have been provided within this section.

- (i) **Demonstration of knowledge of analogue components and their utilisation within**

simple circuits in addition to the use of calculations to explain circuit parameters.

The course will aim to develop the skills of the student in systematic understanding of the core principles of a range of concepts ideas and technologies that reside within the analogue electronics domain.

This provides the student with a unique understanding of the concepts involved allowing them to progress their knowledge further and apply th knowledge to the practices later in the course. The concepts outlined within the initial modules introduce the student to the mathematical and practical laws and principles that will be required throughout the course of the study.

- (ii) **Construct a circuit making use of both digital and analogue components evidencing their operations for specific applications.**

In addition to the outcomes already provided, the curriculum will further develop the students systematic understanding of the principles and ideologies associated with digital electronics allowing assessment of particular applicability to given scenarios. Building upon the knowledge transferred to the students throughout the study of the early modules of the course, students will be far better able to follow the practices within digital electronics. The delivery of such knowledge at this stage, builds upon prior works discussed and affords students the ability to independently discover concepts through practical and theoretical means.

- (iii) **Production of an electronic prototype that incorporates the use of both analogue and digital electronic components utilising software to control finer parameters**

Elements of the course aim to afford students the freedom to learn through creativity and produce innovative works through the application of electronics knowledge. This is complemented by the inclusion of software control elements and concepts. This will result in the ability for the student to produce tangible working prototypes of projects that demonstrate mastery of the subjects covered.

Specific Cross-cutting Themes

The curriculum noted includes many required skills that are not necessarily the core aim of the study. Such skills that are acquired as an aside to those intended are considered to be done so through the inclusion of cross-cutting themes. There is a large element of teamwork within the independent study sessions noted previously with aims towards people understanding design considerations and peer-evaluation with respect to both software and hardware elements. The use of peer-discussion promotes self learning and provides for the opportunity for students to learn from the ideas of others as outlined by Fuchs et al [5] and Smith et al [6]. The inclusion of teamwork in this fashion will improve communication skills and consequently the quality of work produced.

Furthermore, the curriculum incorporates the delivery of key mathematical ideas and principles necessary for theoretically proving the operation of a systemic design prior to its implementation. This theoretical proof allows for a reduction in material costs and similarly results in better quality of the finished product. The use of numeracy as one of the cross-cutting themes exposes the student to some concepts that they would otherwise not have been able to employ in the evidencing of their work. The mathematical underpinning in this context is essential as the selection of incorrect values for some of the analogue components could result in catastrophic system failure and thus injury to the student. It is because of this issue that understanding of these ideas is essential. The equations required for theoretical understanding of the concepts are not necessarily included as a core topic as the course follows a more practical approach to the delivery whereby the practical elements of the course will be utilised to better demonstrate concepts before explanation of the same later.

The final cross-cutting theme is manifest in the form of analytical skills. The student will be expected to understand the fundamentals of electronics and apply such principles to further works. The assessment elements of the course will require the student to identify elements to utilise within their prototype project and and evaluate the efficiency and effectiveness of their design. This requires the student to work in a reflective manner, analysing the outcome of previous design decisions and learning from these. Analysis is a key part of the learning process, particularly so within the discipline. It is believed that the student will progress through each of the stages of blooms taxonomy [4] as they progress through the course culminating in the application of all of the skills learned to a given problem, evidencing their analytical skills throughout.

Teaching Strategy

The teaching strategies employed for this course of study follow a number of differing themes and approaches. The methods of delivery throughout will include:

- Lectures
- Tutorials
- Seminars
- Practical Sessions
- Group Project Work

The course of study makes use of a heavily weighted teaching style in favour of practical sessions for the delivery of working knowledge and demonstration of concepts. This use of practical delivery fosters a kinaesthetic learning environment and affords students the ability to build upon their own knowledge as they progress through the course. The identification of these concepts allows for students to further investigate ideas at their own pace and apply the knowledge gained. This approach follows that taken by Malcolm Knowles et al [1].

It is believed that the use of purely theoretical teaching practices can inhibit the learning process within the discipline of electronics engineering, rendering such concepts very abstract without contextual awareness. The use of practical sessions, however, can make the subject become far more relevant. This approach is central to the teaching and learning strategy of the programme. The development of intellectual skills such as analysis, innovation, critical appraisal and the like will be themes throughout the formal classes and learning process. The learning of these skills are better achieved when applied within the context where they are to be implemented [31], [32].

Where appropriate, formal tutor lead lectures will be conducted to explore some of the more advanced theoretical topics. In addition to exploration, lectures will be used to outline the purpose of the components being used before permitting students to practice these concepts. The skills outlined within said lectures will enable students to further investigate advanced technical skills and apply this knowledge to future projects.

Theoretical Teaching Concepts

The curriculum implemented will include an blend of two different theoretical teaching models used in complement of one another. The two teaching styles that will be used are manifest in the form of the cognitivist and constructivist approaches.

The cognitivist approach is utilised to provision the students with the initial skills that they require in addition to the freedom that is needed in order to explore the application of said skills to newer problems. Students will be required to attend instructional lectures whereby the basic concepts will be delivered. The formal lectures will be accompanied by complementary tutorial sessions in which students are provided opportunity and an environment in which they are able to further explore the ideas discussed. This is reflective of the ideas as discussed by piaget with regard to his ideas in relation to the cognitivist approach to learning, holding utmost concern for the learners individuality and requirement for uniquely tailored tutoring [33], [34].

Care will be taken to ensure that the level of all students is considered in the delivery of the material for each of the sessions. Though the level of study is targeted towards level 5 of the academic scale, it is understood that within this class there may be a disparity between the background knowledge of each of the participants. It is therefore imperative that each of the students are appropriately engaged in a manner applicable to them not dissimilar to the works noted by Piaget [34].

Further to this, the provision of self directed study fosters an environment in which the students are able to take responsibility for their own learning. The use of self-directed learning can pose many issues, predominantly leaving the student with a complete lack of direction. It is therefore important to instil within the students a sense of purpose and confidence within the constraints of the curriculum to ensure that they have an understanding of the bounds of the knowledge to be acquired. This approach is representative of the works proposed by Guy Claxton and his works in relation to the attitude of the learner towards the learning [35], [36].

The ideas proposed by Claxton, revolve around the premise that learners can reside within specific categories holding a belief about their own learning and the progress of the same. Learners are said to reside in the category of robust learners and fragile learners. Robust learners include those individuals who hold confidence, interest and motivation for their own learning whereas fragile

learners are those individuals that are unmotivated and lack confidence in their own abilities. It is consequently the task of the tutor to foster an environment in which the learner is afforded the confidence that they may lack [37]. This will be achieved within the curriculum by the permitting of students to produce materials to deliver to other students in the form of micro-teach sessions, thus re-affirming the understanding of the students through the delivery of the materials. Feedback upon such tasks will be provided, highlighting the positive elements of the tasks undertaken in addition to provision of constructive criticism and direction where appropriate for each of the individual learners.

To complement the inclusion of the cognitivist approach, elements of constructivism have been applied to the devised programme of learning. Constructivism is concerned with the provision of what is termed scaffolding knowledge as a foundation upon which learners may construct their conceptual understanding of the curriculum content. Within the confines of the devised curriculum, the misconceptions with regards to the discipline and the applicability of the concepts will be addressed. This will be explored through the conducting of experiments in the field of electronics to eliminate false assumptions and ideologies held. This adheres to the principles as noted by both piaget [33] and and works as noted by Vygotsky [38].

The use of experimentation in demonstrating the concepts of electronics allows for the student to construct their own ideas as to the approaches taken in the completion of tasks. In addition to this, the observation of elements can be a key factor in the understanding of certain concepts as they provision undeniable proof of the effecting of a process. This is employed within the curriculum through the incorporation of the construction of primitive circuits to highlight the efficiency benefits in the use of appropriate components and the dangers of utilisation of incorrect designs and components, allowing the student to develop schemas with regard to the application of skills to future problems simulating the principles outlined within constructivism and its attention to the learners observation.

Furthermore, the benefits of the use of this approach is further highlighted when considering the requirement of the software element within the course. In many cases it would be difficult to understand the relevance of software within an electronics course, however with the construction of background knowledge as observed by the learner it is possible to prove the necessity of the incorporation of software within the course. This required element that is seemingly unrelated to

the stated content of the course is a prime example of the effectiveness of the use of the constructivist approach [39].

Methods of Assessment

Formative assessment is the aggregation of the constituent components of the body of material with the intent of evidencing of skills learned throughout the course. This assessment promotes self-directed learning affording autonomy in the work engaged in by the learner, effectively coercing them into individual research [7]. This adheres to those principles outlined in the theory of andragogy and adult education [1]. Contrastingly, summative assessment is concerned with the provision of numerically attributed testing material which students are tasked with answering specific criteria composed of all of the knowledge accumulated in a given period [8], [9].

The assessment of this curriculum consists most prominently of formative assessment elements. The use of formative assessment particularly suit this mode of study, allowing students the opportunity to outline the progression through the course. The limited amount of assessable concepts makes it difficult to implement a means of summative assessment. Within the field of electronics it is far more appropriate for students to evidence their work in a more practical sense having proven that they are able to design based upon core concepts.

Formative assessment also suits the provision of the software element in that it provides the student greater opportunity to demonstrate their own ability to apply the learned skills in contrast to the more prescriptive nature of a summative assessment [9], [11]. Though there are issues with the lack of inclusion of summative assessments, the formative assessment elements included permit greater flexibility and greater scope for the student to prove what they have learned in their own manner.

Included assessment will manifest in the form of a presentation of learned concepts and skills alongside a discussion of the application of those skills to a specific problem as chosen by the individual. In addition to this, students will be required to construct a prototype of the project that they have design in addition to implementing a portion of the required software to facilitate its control. It is believed that this will encourage students to further explore the skills outline and progress into an area of interest.

Evidencing Learning

The learning throughout the course will be evidenced through the incorporated formative assessments and consequently production of materials reflecting this. The ability for the student to construct hardware to solve particular problems will provided an appropriate tangible representation of the learning that has occurred. In addition the ability of the student to convey the concepts through a demonstration of the work that they have achieved will also be noted. The description of the skills that have been utilised in the construction of both elements of hardware and software and subsequent explanation of the concepts that are identified will serve as a means for the proving of understanding of techniques.

Students will further demonstrate understanding in ancillary areas with respect to the software elements in the implementation of functional code for the control of the hardware elements that they produce. The implementation of code will be assessed on its observation of standard principles and key notations required. Software will be further validated with respect to its efficiency and maintainability for the application whereby the understanding of the student will be apparent.

Scheme of Work

Lesson No:	1
Title: Duration: Objectives:	Introduction to Electronics 2 Hours • Provide a course introduction • Outline basic concept knowledge as a foundation for further study
Description:	Students will be provided with a comprehensive introduction to the discipline, outlining the use of electronic components and the associated literature to be used throughout the programme. In addition, students will be made aware of the basic constructs for electronics and introduced to the field as a whole including the job prospects and progression following the curriculum completion.
Strategy	Element of teaching will be conducted through the use of a traditional lecturing style. The introduction to the module will involve elements of student engagement whereby they will be asked to introduce themselves and outline what they would like to achieve upon the completion of the program of study. In addition, students will be given the opportunity to observe some of the resources in utilisation by other students on the course. The second hour will consist of group observations and resource usage tutorials.
Lesson No:	2
Title: Duration: Objectives:	Passive Analogue Components 2 Hours • Identify common analogue components • Identify appropriate components • Assess the compatibility and applicability of a component to a given task

Description:	An introduction to the concept of components will be provided in form of a lecture. The introduction will include a brief overview of the most common analogue components in use and focus particularly on those that will be utilised throughout the course. Students will then be introduced to techniques through which they may identify the types of components in addition to the tolerances that they exhibit.
Strategy	The first hour of the lesson will consist of a traditional lecture in which the core concepts and methods for tolerance identification will be delivered. Following this, students will be given the opportunity to test some of the components utilising the skills learned with respect to identification of the tolerances of the same.
Lesson No:	3
Title: Duration: Objectives:	Digital Electronics Revolution 2 Hours • Describe the characteristics of digital components • Identify the necessity for digital components in modern applications • Discrimination of excessively complex components for the task
Description:	This lesson will cover the evolution of electronics as a discipline providing context for the utilisation of digital electronics. As such a comparison will aid in the demonstration of the applicability of suitable components for a particular situation. Students will be provided material in relation to the performance of digital components and a comparison between these and analogue counterparts.

Strategy	Lesson will consist of an amalgamation of lecture and workshop sessions. The delivery of a conceptual idea will be achieved through the means of a very brief 10 minute lecture before providing the student a short session to observe the tangible proof of the concept using physical devices. This pattern will continue for the duration of the 2 hour session, providing students with a less tedious approach to a mundane topic.
Lesson No:	4
Title: Duration: Objectives:	Circuit Theory and Equations 2 Hours • Calculate the EMF of a circuit • Calculate the current being drawn by components • Identify the most applicable equation for use in context • Derivation of equations for given parameters
Description:	Students will be provided an introduction to the theories behind the construction of circuits and the applicable physical laws. An overview of ohms law will be provided in addition to the inclusion of power and the ideas of Kirchoff. This will provide the student with a solid understanding of the underlying behaviour of electricity which will better inform their circuit analysis skills.
Strategy	Lesson will be delivered primarily as a lecture, however will include some elements of practical work for the demonstration of key concepts relating to ohms law. Students will be permitted to utilise the components in the lab in an attempt to further demonstrate the applicability of the equations to the work that they are to undertake.
Lesson No:	5
Title: Duration:	High Power Electronics 2 Hours

Objectives:	• Specify the need for high power electronics • Observation of safety measures within high-power system • Demonstration of protection components within high-power circuits
Description:	A comprehensive description of the use and applicability of high-power solutions when utilising electronics. This will cover the ideas behind the use of control logic and the disparateness between itself and high power systems. The concept of optocoupling will be introduced in addition to the use of MOSFETs.
Strategy	This session will take place as a complete tutorial. Concepts will be demonstrated through the use of apparatus for the control of high power systems. Extensive use will be made of measuring and test equipment to demonstrate the imperative nature of safety, in addition to demonstrating the aftermath of poor design and implementation.
Lesson No:	6
Title:	Microcontrollers
Duration:	2 Hours
Objectives:	• Outline the operation of a microcontroller • Identify appropriate solutions for the use of microcontrollers • Prescribe tolerances for circuits that utilise microcontrollers
Description:	A complete introductory session on microcontrollers, the history of the same and the applicability to a given problem. In depth knowledge will be conveyed relating to the internal structure and operation of such devices with respect to their use within electronic control systems.

Strategy	Class will consist of a two hour workshop in which the lecturer will lead a guided tutorial session for the group. This will enable the group to explore common issues and debugging practices throughout the session.
Lesson No:	7
Title: Duration: Objectives:	Digital Electronics Control 2 Hours • Identify the applicability of use of digital components • Describe the mechanism of functionality for each component utilised • Compare benefits and detriments of the use of such components
Description:	Outline of the use of software for the control of digital electronics elements. This will include the nature of the control and the safety implications required for the management of such devices.
Strategy	The majority of provision for this session will take place in group guided labs with continuous reference to the apparatus available. Concepts will be both demonstrated and discussed with respect to both implementation and mitigation of failures.
Lesson No:	8
Title: Duration: Objectives:	Hardware Prototyping for the Hobbyist and Professional 2 Hours • Describe the process of circuit board fabrication • Compare and contrast the major differences between industrial practice
Description:	Identification of procedures and practices utilised for the production of prototype test equipment. This will be done so in both a personal and professional aspect and the disparity between both explored.

Strategy	Students will participate in a workshop whereby they will first design a simple light control printed circuit board and progress to the fabrication of this board following appropriate professional practice. This will be achieved under the supervision of individual instructors assigned to a group of five students.
Lesson No:	9
Title: Duration: Objectives: Description: Strategy	Software Development for Professional Electronics 2 Hours • Describe the key elements of software development • Selection of appropriate constructs for software for electronics circuits Session will provide an overview of the approach taken to software development for digital controller logic within a professional environment. Students will explore the requirements for standards and testing within the field. In addition students will perform analysis tasks identifying areas of concern.
Lesson No:	10
Title: Duration: Objectives: Description:	Software Signal Control 2 Hours • Discern between the different types of signal generation • Selection of the most appropriate signal for the application • Describe the importance of amplitude and frequency in signal controlled systems This session will provide an introduction to the use of signals to control hardware and machinery. Throughout the lesson students will demonstrate the use of such signal interaction in attempts to control appropriate devices.

Strategy	Session consists of lecture lead tutorial session where the applicability of certain signals are identified. In addition the importance of device tolerances are considered with respect to the application of such signals.
Lesson No:	11
Title: Duration: Objectives:	Group Project Prototype Proposal 2 Hours • Identify individuals with similar intent • Identify a suitable application or problem • Identify a suitable means of approaching the problem
Description:	Students are to provide a proposal and a limited design specification for a hardware prototype that solves a problem chosen by themselves. The student will then justify these ideas to the tutor taking the class.
Strategy	Student will be provided time to individually or through teamwork, decide upon a particular problem that could be solved by the implementation of an electronic system and analysis this problem resulting in the design and specification of the system that they would implement.
Lesson No:	12
Title: Duration: Objectives:	Concept Design of Project 2 Hours • Progress design of possible solutions previously identified • Conceptually test those ideas with respect to the application through the use of theoretical approaches
Description:	Student is to perform same process as identified in the fabrication of light controller producing a prototype for their project identified in previous session.

Strategy	This session will consist of a student lead tutorial element in which students are afforded time to perform the fabrication of a primitive hardware prototype for the electronic solution to the problem that they have identified.
Lesson No:	13
Title: Duration: Objectives:	Project Prototype Presentation 2 Hours • Devise presentation mechanism of the hardware element produced • Identify areas where complex concepts have been implemented
Description:	The student will provide a demonstration of the conceptual prototype, identifying the problem area that they are tackling and the applicability of the solution they have created to that area.
Strategy	Students will be provided an allocated appointment in which they are able to demonstrate the prototypes that they have created for their chosen problem domain. This session constitutes an assessment of the work performed from a physical perspective with observation of the quality of the work produced.
Lesson No:	14
Title: Duration: Objectives:	Project Software Workshop 2 Hours • Identification of appropriate software implementations • Implementation of limited software solution • Validate the implemented software ensuring that it meets the standards discussed
Description:	Students will decide upon the software control element they wish to implement. Students will then proceed to develop the said control element employing the use of appropriate programming constructs throughout

Strategy	This is a student lead tutorial session in which students will be permitted the autonomy and freedom to construct the control software element for their project
Lesson No:	15
Title: Duration: Objectives:	Project Demonstration 2 Hours • Demonstrate the finished combination of both hardware and software elements of the project • Outline any areas where there could be improvements upon the process
Description:	Students will demonstrate their completed projects in a holistic capacity, highlighting the skills that they have utilised in addition to the concepts applied throughout. The student will evidence their adherence to professional practice throughout with a demonstration of analysis.
Strategy	Each individual student will participant in a discussion with regards to the projects that they have undertaken whereby they will discuss the concepts and techniques applied to the creation of the solution to their chosen problem. This will form the second element of the formative assessment to this course.

Academic Critique

This section will constitute an academic critique of the designed curriculum in addition to assessing the applicability of the scheme of work with respect to the delivery of knowledge and teaching to the students concerned.

Curriculum Overview

The curriculum proposes to deliver material to a demographic that resides within the national academic scale situated at level 5. This level of study constitutes the second year of an academic degree course within the united kingdom. At level 5 the QAA requires that the level of study include the following elements:

- Knowledge and critical understanding of the well-established principles of the discipline.
- Ability to apply the concepts learned through tuition to other scenarios in the discipline.
- An understanding of the main methods of enquiry within the given discipline
- An understanding of the limits of the learners knowledge

[12]

The course that has been designed, in most cases, meets or exceeds the criteria as specified within this definition. The delivery of materials to students is done so in such a way that it provides the learner with the initial tools and skills for understanding of the core concepts. The lesson structure enables the student the ability to further their own learning with respect to the application of the skills to the wider context of the discipline and new problems throughout the course of study and into professional practice. In this case exceeding the expctations as defined by the QAA framework [12].

Structural Design

The course structure provides for a means of affording students the autonomy to take responsibility for their own learning in many areas. In addition the designed curriculum introduces many new topics and covers theory in much the same way that traditional lectures are conducted. There are many benefits to this in that it addresses the idea as proposed by Vygotsky and piaget with respect to the learners perspective upon their own learning and responsibility for it [33], [38]. There are however implications to the inclusion of such a heavy self directed learning element. Further to the ideas as discussed by Guy Claxton, the resilience or robustness of the learner could have a detrimental impact upon the learning process as a consequence of the learner's attitude toward the topic area and learning process [36], [40]. This is somewhat mitigated by the inclusion of tutor lead sessions, providing limited direction to the students where necessary and a point of contact for the student should they require it.

Curriculum Aims and Learning Outcomes

The included curriculum aims are clearly defined with provision of an explanation of the achievement of the same. The Aims are achievable within the given time frame and as such adhere to the guidelines for this level of study as defined by the HEA.

Curriculum Model

The curriculum model observed within the proposed programme of study is manifest in form of the process model for teaching. This model constitutes the continued evidencing of learning achievement through the construction of the students own schema of the work. this allows for the student to effectively progress at their own pace and apply the knowledge they have learned in a way that works for them [41]. The use of the process model in this case makes it more likely that students will understand the topics being covered affording them the opportunity to explore the more advanced topics through their own direction.

The assessment methods in this case are present in formative elements that address the understanding of the student through the representation that they have produced. This can result in a non-standardised means of assessment resulting in an uneven marking scheme and lack of direction for the student [42]. In some cases the use of the more rigid product model would have provided for a more rigid testing structure particularly so in the case of assessment of understanding of the equation and mathematical elements of the course [43].

Critique

The course that has been outlined provides for a comprehensive introduction to electronics engineering. In addition it includes a software element by which students will be exposed to the use of the same within the field of electronics. The course meets the standards required of the level of study and the vast majority of the tuition outlined has a beneficial impact upon the student. There are however elements that are detrimental to the learning process for the student.

Beneficial Elements

The students are afforded a large capacity in which they are able to undertake self-directed learning. This self-directed learning allows for the learner to learn at their own pace in a way that best suits their learning styles. The incorporation of this element promotes the importance of the student and their role within the learning process. This can have a positive impact upon engagement of the student and the performance shown within the work [44].

In addition to the student directed learning the course incorporates the use of tutor led sessions, whereby the tutor will provide direction to the student. This ensures that the student has some form of direction throughout the learning process and does not resort to feeling lost and confused. Further to this, the tutor may provide encouragement for the student and thus motivate the student to perform better and thus promote engagement within the student [45].

The inclusion of formative assessments throughout the course of study elucidate an effective means of monitoring the progression of the student knowledge in a largely student directed learning process. The student is permitted a means to produce small assessed elements at differing intervals reducing

the pressure that may be inherent in summative approaches [10]. In addition, students are afforded the luxury of interpretation of the assessment criteria and the freedom of defining the constraints of the problem.

Detrimental Elements

The inclusion of such a heavy self-directed learning element although beneficial in some forms holds some negative impact upon the student. In a similar fashion to the proposed ideas of Guy Claxton, Some learners hold a wholly fatalistic view of their own abilities and as such hold a pessimistic notion that they are unlikely to complete. Furthermore there are some students who may reside on the opposite end of this scale holding an unfounded belief that they are unable to fail [46]. This can cause issue particularly with respect to guidance and marking of the solutions provided by the student.

For some tutor lead sessions are the preferred mode of study, however, there are those students that find it difficult to transition between the two and as such become confused with what is to be constrained by the tutor and what is at the discretion of the student. This could lead to inconsistencies within the grading of each of the students showing disparity between those that have been provided direction and those that chose to refuse the same [44].

The use of formative assessment can be particularly beneficial to those students that suffer with the anxieties of exam pressure. There are however issues with the administration of formative assessments in this case. The methods and intervals chosen for the given formative assessments for this course of study are at risk of over assessment throughout. The curriculum outline and the scheme of work both outline the intervals of formal assessment in two areas, however, there are several elements at which the learners are observed. This may provide the impression to the student that every element is being observed and contrary to the intent result in the increase in anxiety and pressure of achieving within the programme [47].

Conclusion

Overall the designed course provides for an appropriate and effective means of tuition for the level and discipline noted. Though there are detrimental elements noted, it is believed that the positive impact upon the learning process negates the issues noted. The effective use of a combination of the process model in addition to the included formative assessments make for an effective way in which the student may direct their own learning and additionally follow a guided programme of study.

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Notes