Standards and Contextual Sensitivity in Computer Science/Information Technology degree curricula: A Case of Five Sub-Sahara Africa Universities.

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Abstract

This thesis paper studies five degree curricula models for Computer Science and Information Technology degree programs that are offered in five different universities in the Sub-Sahara African region. The study aimed to examine the adherence of the degree curricula models to international standards of the disciplines and the sensitivity of the curricula models to local society needs. This study is important because it addresses issues related to degree curriculum development and implementation in higher education institutions (HEIs) and leads to the understanding of these issues.

The study employed qualitative research design. The methodology used was that of a multiple-case study approach since it involved the study of degree curriculum model from Kabarak University (Kenya), Tumaini University (Tanzania), Makerere University (Uganda), University of Namibia (Namibia) and University of Pretoria (South Africa). In order to investigate the adherence of the curricula models to international guidelines and recommendations given in the CC2001 and IT2005 reports, comparison of the findings from the universities involved to the characteristic features common in both CC2001 and IT2005 reports was necessary. Comparison of the findings to the roles of HEIs in an *information society* was also done in order to investigate the contextual sensitivity of the degree curricula models.

The results showed that the degree curricula models complied with the international standards in CC2001 and IT2005 reports in their organization. The curriculum organization included the body of knowledge of the curricula models, the structure of the curricula models and the implementation strategies used. The benefits and the objectives of the curricula models to an extent addressed the local needs of the society around the institutions. This is because benefits and objectives of the degree curricula models reflect the output product of the models.

ACM Computing Classification System (1998): K.1[The Computer Industry], K.3.2[Computer and Information Science Education], K.4.3[Organizational Impacts], K.7.1[Occupations]

Keywords: CS, IT, Education, Curriculum, Standard, Higher Education Institution, Information Society, Context.

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Chapter 1

Introduction

Computing is a large field of study and it comprises of several interrelated fields; Computer Science (CS) and Information Technology (IT) disciplines, which are focused in this study, are part of this field [Curricula, 2005]. The scope of CS can be divided into three categories according to the work of the computer scientists: they design and implement software, they devise new ways of using computers and they develop effective ways to solve computing problems [Curricula, 2005]. IT, apart from being a discipline of computing, also refers to undergraduate degree programs that prepare students to meet the computer technology needs of application domains. This is through the selection, creation, application, integration and administration of computing technologies. IT is more application oriented than traditional CS [ITcurricula, 2005].

This study particularly centers on curriculum development for undergraduate studies of the academic disciplines of CS and IT. Higher Education Institution (HEIs) offering CS and IT degree programs differ from each other in their implementation of the programs' curricula models. This is mainly due to difference in standards followed, goals and objectives of the curricula models in the respective institutions [ITcurricula, 2005]. Differences may also arise because of the contextual issues which are taken into consideration during the development and implementation of the models [Vesisenaho, 2007].

There are many reports concerning curriculum development in computing fields which are as a result of many studies. An example of these reports are the Computing Curricula series [Curricula, 2001]. Organization bodies involved in curriculum development studies include, for instance, Association of Computing Machinery (ACM), Institute of Electric and Electronic Engineers(IEEE), Association of Information Systems(AIS) and International Federation of Information processing(IFIP). The reports used in this research study as reference points are CC2001 and IT2005.

These reports offer guidelines and recommendations on how to develop an undergraduate degree curriculum model in CS and IT respectively. These guidelines and recommendations are flexible and can be used by any HEIs across the globe offering degree programs in CS and IT [Curricula, 2001].

Therefore, this study examines the degree curricula models for CS and IT implemented in five Universities in SSA to investigate their role in responding to the needs of the society, and on the other hand, their compliance to the disciplinary standards set out in CC2001 and IT2005.

1.1 Thesis Statement

There are three aims for this study:

1. This study aims to get an overall understanding of the CS and IT curricula models implemented in the universities under study. This will be achieved through the analysis of data collected from the respective institutions.

2. This study aims to find out the extent in which the degree curricula models adhere to the guidelines and recommendations in CC2001 and IT2005 guidelines. It particularly references to the guidelines and recommendations in CC2001 and IT2005 reports because they have been broadly based and widely accepted by the computing community as the standard guidelines for degree curriculum development in the respective fields [Curricula, 2001] and [ITcurricula, 2005]. This aim will be achieved by investigating the elements in the curricula models and compare them to the features present in both CC2001 and IT2005.

3. This study aims to find out the extent in which the degree curricula models, in their respective universities, address the needs of their local societies. This will be achieved by investigating the contribution of the curricula models to the overall roles of HEIs in the *Information Society*.

1.2 Research Questions

This study seeks to answer the following key questions:

- What guidelines and recommendations, standards, or models, does the CS or IT curriculum implemented in respective universities follow?

- How has the implementation of the CS or IT degree curriculum in the respective universities addressed the local society needs around the institutions?

1.3 Scope and Limitation

The scope of this study is limited to the analysis study of CS or IT degree curricula models implemented in Kabarak University (Kenya), Tumaini University (Tanzania), Makerere University (Uganda), University of Namibia (Namibia) and University of Pretoria (South Africa). These institutions were chosen mainly because they are within SSA region and also because they have had collaborations with the University of Joensuu (Finland). The other reason is the difference in their geographical locations in the map of Africa which gives the study a wider coverage of the SSA region and bringing variance in degree curriculum development and implementation in CS and IT. The curricula models from these universities are compared to the international guidelines and recommendations for curriculum development in CC2001 and IT2005 reports. The reports were developed by ACM and IEEE-CS and Special Interest Group IT Education(SIGITE) of ACM respectively. Figure 1.1 shows the scope of this study.

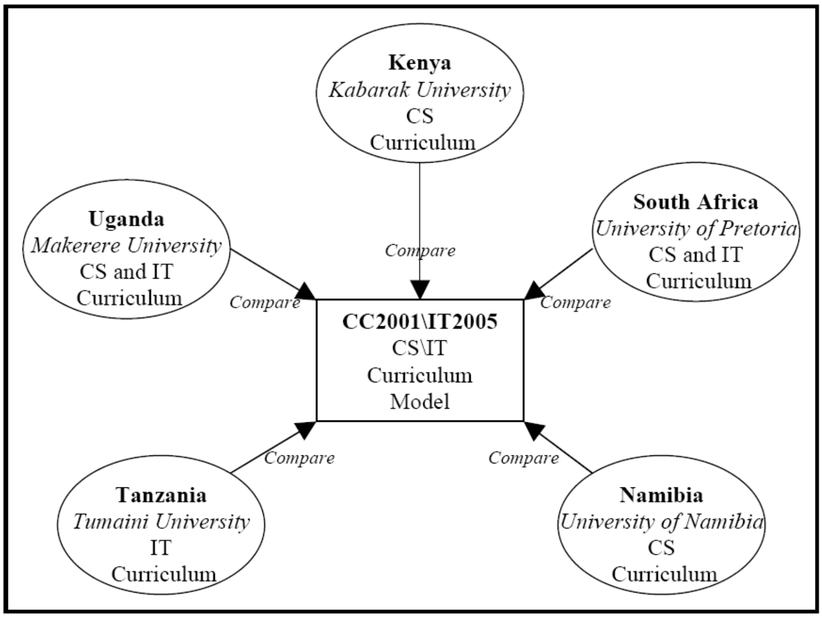


Figure 1.1: Scope of the Study: CS or IT degree curricula models implemented in the five Universities in different context areas in SSA region, compared to either CC2001 or IT2005 respectively.

Limitation

One limiting factor of this study is on the difference in the level of establishment of CS and(or) IT degree programs in the respective institutions. In some institutions, the degree programs are well advanced while in some other institutions they are still young and establishing. This is because of the difference in the commencing periods of the degree programs in the respective institutions and the length of period the universities have been in operation.

1.4 Terminology

In this study, the term contextual needs has been used on several occasions in place of local society needs to refer to the same meaning. The term contextual sensitivity refers to how the curricula models responds to the needs of the society around them.

1.5 Thesis organization

This thesis paper contains eight chapters. Chapter one contains the introduction. Chapter two describes the contextual impact of ICT and HEIs. Chapter three contains details about the computing curriculum standards specifically about CC2001 and IT2005. Chapter four describes the context of this research study i.e. the background information of the context areas on the universities under study. Chapter five describes the research design and methodology used for this study. In Chapter six, there are analysis of data from each university case according to ten categories derived from chapter 5. These categories create the structure of the case study database used in this study. Chapter seven discusses the interpretation of the standards and contextual sensitivity of the curricula models from the universities under study. Chapter eight draws the conclusion and recommendations of this study.

Chapter 2

Contextual impacts of ICT and Higher Education

Information Communication and Technology also known as IT is becoming a necessity in our lives. Technology is advancing at a fast rate and everyone is keeping up breast with it. There are a number of ICT definitions given by various academicians, philosophers, ICT experts and many others. For instance, the United Nations ICT Task force define ICTs to include the full range of electronic technologies and techniques used to manage information and knowledge [UnitedNations, 2003].

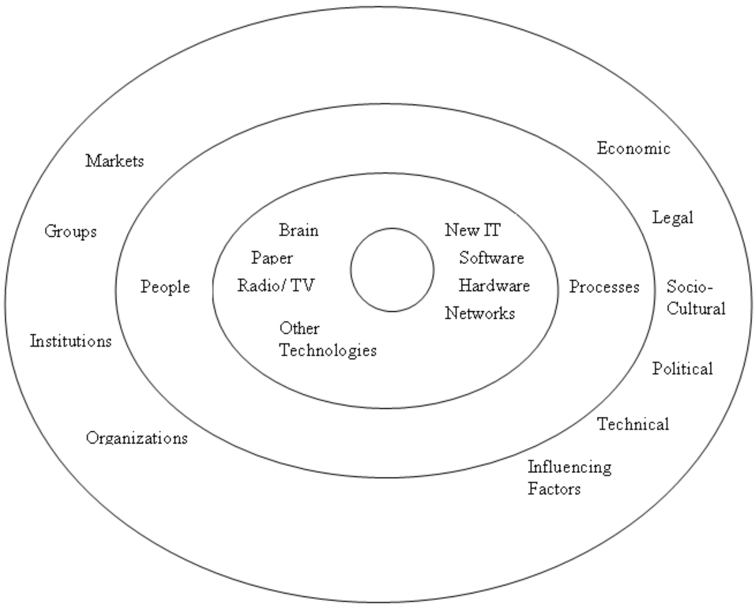


Figure 2.1: A Model defining the scope of ICT [Allen and Thomas, 2000]

Figure 2.1 shows the scope of ICT as defined by Allen and Thomas [Allen and Thomas, 2000].

At a glance, there are two sections, information and technology. In the innermost realm; there are different sources of information and different types of technologies used to process the information. In the middle realm, there are people who make use of the technologies and the information and there are processes implemented by the technologies to process the information. This forms an information system. In the outermost realm there are other factors that influence the use of ICT such as economic factors, legal factors, political and technical factors etc and we also have groups or places where the use of ICT is applicable such as organizations, institutions, groups and markets among others.

Therefore, ICT is a broad field that not only encompasses things to do with technologies but also people, groups, societies, nations, businesses, industries, institutions, governments among others and also the impact of ICT in people's lives and work activities, hence an *Information Society.*

ICT is a tool for development, just by its basic operations of storing, processing and retrieving information, affordable and effective means of communication and also running of work activities in organizations, development initiatives in a country is achieved with ease.

The United Nation ICT task force gives a number of ways in which ICTs can be used to bring about development in countries. For instance, ICTs are used in economic activities to achieve high growth rates in both developed and developing countries and also as a platform for communication to exchange data, information and knowledge and also application tools to operate different kinds of social activities such as e-banking, e-learning, e-commerce etc [UnitedNations, 2003].

The United Nations Development Programme (UNDP) regards ICTs as an increasingly powerful tool for participating in global markets, promoting political accountability, improving the delivery of basic services and enhancing local development opportunities [UNDP, 2006]. However, they emphasize that without appropriate ICT policies, the ICTs will not be of much use as the policies are there to give guidelines and best practices in developing strategies to expand access to ICT and harness it efficiently and effectively for development [UNDP, 2006].

In the subsequent sections, I will describe *information society* in five perspectives as defined by Frank webster, followed by ICT in HEIs and development and then role of HEIs in development, globalization and sustainability.

2.1 Information Society in five perspectives

Frank Webster distinguishes five ways of defining an *information society*; technological; economical; occupational; spatial and cultural [Webster, 2002b]. However, he argues that in each of these definitions, there is a common reasoning which is, there is more information nowadays and hence an *information society* [Webster, 2002b]. The following approaches define an *information society*:

2.1.1 Technological Approach

This approach describes an *information society* in regard to the technological aspects in a society. Webster argues that technological conceptions center on an array of innovations that have appeared since the late 1970s and these new technologies are one of the most visible indicators of new times. They indicate the coming of an *Information society* since they have a profound impact on our social world [Webster, 2002b]. He quotes Alvin Toffler (1980) who suggested that our way of lives have been decisively shaped by three waves of technological innovations; first one being agricultural revolution, industrial revolution and more presently, information revolution. The technologies include cable and satellite televisions, computer to computer communications, personal computers, new office technologies, notably online information services, word processors, CD-ROM facilities, telecommunications, email,data and text communications among many others [Webster, 2002b].

2.1.2 Economical Approach

In this approach, the *information society* is defined in terms of the statistical value of information industries to the gross national product. This approach charts the growth in economic worth of information activities [Webster, 2002a].
The information industries being referred to here include: education e.g schools, libraries, colleges etc, media of communication e.g radio, televisions, advertising etc, information machine e.g computers, printers, projectors etc, information services e.g law, insurance, medicine, teaching, banking etc, research and development, non-profit making activities among others [Webster, 2002a] and [netTel@Africa, 2004].

2.1.3 Spatial Approach

In this approach, the point being stressed or that which indicates an *information society* is information networks. Where the society is connected in order for people to efficiently and effectively exchange information regardless of the geographical barriers [Webster, 2002a]. The society can be connected nationally, internationally and even globally to provide information to individual(s) in institutions, offices, businesses, homes, laptops, and even on mobile phones etc [Webster, 2002a]. Within the information network, there is information that is shareable, communication technologies that provide the infrastructure in which the information can be stored, processed, retrieved and exchanged, information services that uses and avails information to the society such as media: televisions, radios, internet, medicine, banking, teaching etc and connection to other networks hence forming, regional, national, international and global networks [netTel@Africa, 2004].

2.1.4 Occupational Approach

This approach highlights the changes in our society with respect to the use of ICT in people's work places or work activities. It refers to the decline of manual jobs as more people are being employed in the service sectors [Webster, 2002b]. Webster defines an *information society* in the concept of occupational change by suggesting that we have achieved an *information society* when the preponderance of occupations is achieved in information work. Information is the raw material for non-manual jobs and it can be manipulated in various work areas or work environments to bring about development in the society and also improve the living standards of people [Webster, 2002a].

Webster emphasizes that the concept of *information society* in regards to occupational change is different to that which regards ICT as an aspect that defines the *information society* [Webster, 2002a]. This concept regards information as the distinguishing element that marks the new age and not IT; it is how people use and manipulate the information generated in occupations or instilled in people through education and experience [Webster, 2002a]. Webster quotes Leadbetter in arguing about how to make a living in the information age by thinking smart, being inventive and having the capacity to develop and exploit networks, since wealth production comes not from physical effort but from ideas, knowledge, skills, talent and creativity (Leadbetter, 1999:18) [Webster, 2002a]. Thus, he regards HEIs as places where this knowledge, skills and talents are nurtured into people but as new concepts and innovative ideas come into the light, the graduates must keep on updating themselves in order to be productive and hence a lifelong learning process [Webster, 2002a].

2.1.5 Cultural Approach

In cultural approach, there is a considerably large amount of information available in our everyday lives [Webster, 2002a]. Information is availed to us through many forms, for instance, the internet, television sets, radios, newspapers, movies, advertisement notices and billboards among other things. Webster gives an example of how at the present times TV receivers or sets have been enhanced to incorporate video technologies, cable and satellite and even computerized information services [Webster, 2002a], hence an *information society.*

2.1.6 Summary

Figure 2.2 gives a summary of the scope of ICT and an overview of the theories of an *information society* as described in this study. The innermost realm represents technological approach which includes the technologies that define an *information society.* In the second inner realm, there is cultural and occupational approaches and it contains people and the information groups formed where they process the information available using the existing technologies to perform their work activities and improve their standards of living. The third inner realm has economical approach which contains factors that influences the use to ICT such as education, banking, marketing, communication and health among others which contributes to the growth of the country's economy. And, the outer most realm has spatial approach which includes information networks that connects societies, regions, nations and even globally regardless of geographical barriers.

2.2 ICT in Higher Education and Development

2.2.1 Application of ICT in Higher Education Institutions

HEIs in the African countries are faced by many challenges that hinder HEIs' functionality and delivery as compared to the HEIs in the western or developed countries. A few examples of these challenges include limited or inadequate educational facilities and infrastructure, lack of adequate learning materials, low participation rates in higher education, poverty, low performance rates by students in the lower educational levels, HIV/AIDS and other health related issues among many other challenges [Moja, 2002].

As Webster describes that information networks define an *information society* in the spatial approach, HEIs are information network centers as they contain the country's state-of-the-art technologies within their premises with the ability to connect the society to other societies internationally and hence members of the society can make use of them. They are technological centers in the technological approach because of the availability of several different types of technologies under one "roof" that can be used for different purposes. In the occupational approach, they are knowledge

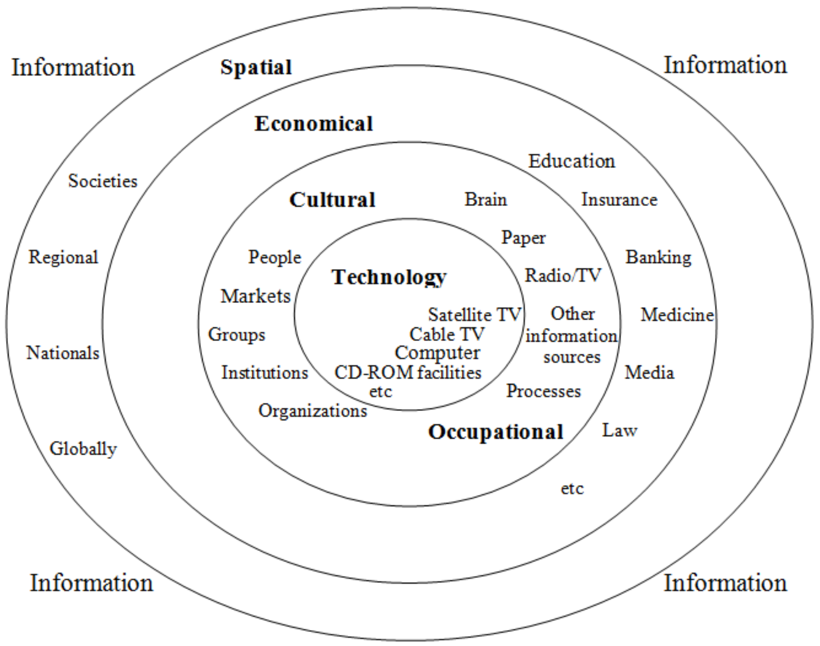


Figure 2.2: A joint diagram showing the scope of ICT in an Information society

centers as they train and instill knowledge and skills to members of the society on how to manipulate information. Therefore, in order for HEIs to combat some of the challenges faced, they make use of ICT in the running of their educational systems. They benefit from them as there is efficiency in delivering educational services, better communication channels, availability of learning and teaching materials. These increases the participation rates of the students in institutions, creating good learning environments, providing adequate educational materials and hence increasing the quality of educational services.

The communities around the educational institutions benefit from the institutions' ICT facilities, through the use of the facilities for communication purposes, learning the benefits of ICT in their lives, learning how to use computers and to run ICT projects that will help solve some basic problems within the community. For instance, Kabarak University (Kenya) runs programs called End User (EU) programs at affordable prices for anyone who would like to be computer literate and at the end of the program, the students are given certificates showing what they have done and how they have performed. University of Pretoria's (South Africa) CS department in 2003 was involved in a community-based project called *pumascope*, which involved a collaboration between South African department of Education and the Finland ministry of Foreign affairs. The aim of the project was to help historically disadvantaged and rural schools in provinces of South Africa where there were no HEIs situated by facilitating knowledge transfer from university students to selected rural school teachers and pupils [UP-CS, 2008]. University of Namibia in collaboration with Ministry of Education, Namibia College of Open Learning, Polytechnic of Namibia and National Institute of Educational Development formed a Namibian Open Learning Network Trust(NOLNet) initiative to establish a network of open learning centres throughout the country at which certain facilities will be shared and services offered on a collaborative basis [Isaacs, 2007a].

2.2.2 Role of Higher Education in Development

The recognition that knowledge and the production of skilled workforce is the key to development has placed a lot of demands on the education and training systems, especially the tertiary educational systems [Williamson, 2006] and [Moja, 2002]. Thus, governments in African Countries have realized the importance of HEIs to their country's human capacity for national development and are now putting more focus to tertiary educational matters. A few examples of the governments' initiatives from the countries understudy include, the government of Kenya which established a Higher Education loans board(HELB) in 1995 to help Kenyan learners or students to further their studies in the HEIs in the country by giving loans, scholarships and other kind of services [HELB, 2002]. The South African government established the Council of Higher Education (CHE) to manage the higher educational system [CHE, nd] and Center for Higher Education Transformation (CHET) to mobilize trans-disciplinary skills for specific research and capacity development projects by tapping available expertise in the national and international higher education sector [CHET, nd]. The Ministry of Education and Sports in Uganda is responsible for educational matters in the country at all levels, and within the higher education department, there is a division for administering scholarships [MOES, nd]. The Ministry of Science, Technology and Higher Education in Tanzania caters for Higher educational matters in the country.

The role of HEIs in development can be summarized by a quote in Bloom et al [Bloom et al., 2006] where they quote Kofi Annan in his recent speech:

"The university must become a primary tool for Africa's development in the new century. Universities can help develop African expertise; they can enhance the analysis of African problems; strengthen domestic institutions; serve as a model environment for the practice of good governance, conflict resolution and respect for human rights and enable African academics to play an active part in the global community of scholars."

HEIs are part of an *information society* and they have a role to play in the development of the society. Hence, by developing African expertise, in the African context, they play a role of producing knowledgeable and skilled workforce who would be experts in their fields. These experts would bring about development in their countries through their work in their specific areas. This notion is also supported by CHET in their article where one of the roles of higher education in development is "higher education as a producer of appropriately skilled professionals and applied knowledge" [CHET, 2006]. Thus, HEIs are knowledge centers where people are trained with necessary knowledge and skills to be able to be productive and hence participate in nation building and improving the country's economy status. Webster regards information and not IT as the distinguishing element that defines an *information society.* He acknowledges that this information is instilled in people through education and experience [Webster, 2002b], therefore supporting the role of HEIs in producing knowledgeable and skilled graduates.

The other role of HEIs is to enhance the analysis of African problems. This regards research activities carried out by HEIs in investigating problems in African societies and formulating technological solutions to these problems by the use of ICT. CHET supports this notion by describing the role of HEIs as being an "engine of development in the new knowledge economy" [CHET, 2006]. Therefore HEIs create the best environment as a starting point to develop and research on such new knowledge and the integration of ICT to provide solutions to technological problems.

HEIs strengthen domestic institutions by being a "supplier" of information, knowledge, trained human resources, technologies and application systems to the other institutions in the society and hence strengthening them. This role involves research activities in different areas that regards the operations of these institutions and production of the knowledgeable and skilled graduates for these institutions. Examples of the domestic institutions include medical centers, law firms, organizations, agricultural, information and manufacturing industries among others.

Knowledge is a vital aspect in everything. A country relies on its knowledge to improve its economy. In the present world economy, statistical data suggests that without a substantial number of University-trained professionals, a country cannot advance [Pryde et al., nd]. The same point is supported by Webster in mentioning that: today's movers and shakers are those whose work involve creating and using information [Webster, 2002a]. HEIs are thus known as knowledge production centers because through its roles the overall development in a country is achieved.

2.2.3 Role of Higher Education in Globalization

Through HEIs being information network centers in the society, their role in globalization can be discussed. HEIs facilitate communications and collaborations between people, sectors and industries in different societies and in different geographical locations, yielding productive outcomes and hence, they participate at a global level. Globalization describes activities at an international level, and in this case higher educational activities. There are various definitions given of globalization in the literature. Jan Aart Scholte (2000: 15-17), presents five definitions of globalization and among them, the definition "globalization as universalization" is in line with this context as it describes globalization as the process of spreading objects and experiences to people at all corners of the earth [Smith, 2002]. Example of these objects and experiences are computing, ICT, television, telecommunication, knowledge, education etc . In this case, HEIs will be referred to as "world class HEIs".

There are various ways in which HEIs can participate in the global world, for instance through collaborations between universities. Examples of such collaborations include Universitas 21 which is an international co-operation of 20 leading universities formed by the News Corporation in May 2000 [FuturesProject, 2000]. Another example is the European Consortium of Innovative Universities (ECIU) which provided a platform in 1997 for some of Europe's most innovative universities to come together to form a new continent wide network, share and build on their successes as entrepreneurial institutions [ECIU, nd]. These collaborations create opportunities for the institutions on a scale that none of them would be able to achieve operating independently or through traditional bilateral alliances [Universitas21, nd]. The students also benefit through forums such as student exchange activities and summer schools which enables them to move from one member university to another [Universitas21, nd].

Moja [Moja, 2002] states that establishing partnerships with other knowledge producers and participating in innovation hubs is another way to respond to globalization. Hence, HEIs in the developing countries need to form partnership with HEIs in developed countries and thereby sharing knowledge and innovative ideas. Another way can be through co-operation in capacity building for those institutions that in some cases have paid little or no attention to knowledge production due to financial constraints. For instance some HEIs in the SSA countries may lack some ICT facilities that could facilitate and enhance its learning and therefore co-operation with other HEIs that have these facilities will promote sharing of facilities and hence capacity building.

2.2.4 Sustainable use of ICT and Higher Education

Sustainability in this context is sustainable development through higher Education and the use of ICT. The period 2005-2014 has been designated as the United Nations Decade of Education for Sustainable Development (UNDESD) in relation to the Education for all initiatives, the UN literacy Decade and the Millennium development goals [Williamson, 2006]. The objective for sustainable development is to create an enabling environment for people to enjoy long, healthy and creative lives, and this can be achieved through Education and the use of ICT. Both the educational system and the application of ICT have to be relevant and appropriate for the context in use. Education for sustainable development has to be locally relevant and culturally appropriate, that is, it should be based on local needs, build civil capacity, be interdisciplinary and use of variety of pedagogical techniques [Williamson, 2006]. The same point is supported by Sutinen and Vesisenaho [Sutinen and Vesisenaho, 2006] on the concept of Ethnocomputing, which is finding culturally suitable entry points for understanding, utilizing and producing ICT in a relevant way.

Higher education is viewed as the "engine for development in the new knowledge economy" and ICTs is considered as a tool for development, thus with the integration and use of both, there is a greater impact towards sustainable development. There will be skilled and knowledgeable people to steer-head sustainable developmental projects, there will be improved living standards of people in the African countries through up-to-date information resources on health, business and educational issues etc, people will be aware and informed of their human rights and be able to protect it, the poverty level will be reduced among other benefits and hence, people will enjoy a long, healthy and creative lives.

Chapter 3

Computing Curriculum: International Standards

This chapter involves discussions about international guidelines for curriculum development and implementation in two computing fields: CS and IT. The discussions will be based upon two reports CC2001 and IT2005 for each of the fields respectively. Figure 3.1 describes the organization of this chapter.

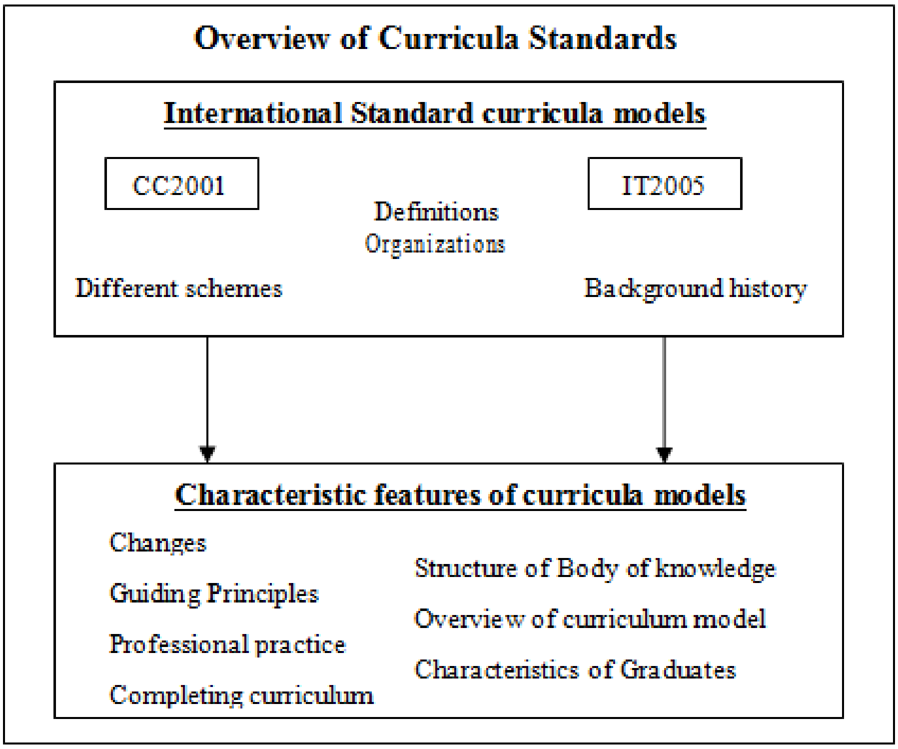


Figure 3.1: Evaluation of CC2001 and IT2005 according to the common characteristic features

3.1 Organization Bodies involved in computing curricula

There are several leading scientific or non-scientific based organizations involved in improving the quality of computing studies through curriculum development. Organizations such as Association of Computing Machinery (ACM), Institute Electrical and Electronic Engineers- Computer Society (IEEE-CS), Association of Information Systems (AIS), career-space, IFIP and UNESCO have long been involved in providing guidelines and recommendations in developing discipline specific computing curricula.

Association for Computing Machinery (ACM) is an international scientific and educational organization dedicated to advancing the arts, sciences and applications of IT. Its also the world's oldest and largest educational and scientific computing society. The members of this society include computing professionals and students from various sectors of IT all over the world [ACM, 2007]. Within this organization, members have organized themselves into groups(Special Interest Groups(SIG)) relating to their common interest in different areas in the computing discipline and they have conducted numerous activities that enable each member and other interested people to benefit from the wealth of information knowledge and skills. Examples of these groups are SIGITE for IT Education, SIGCSE for CS Education, SIGCAS for computers and society among many other groups.

Institute for Electrical and Electronic Engineers (IEEE), is the world's leading professional association for the advancement of technology [IEEE, 2007]. These organization has also organized its members according to their common interest into societies among which computer society is one of them.

CareerSpace is a consortium of major ICT companies: BT, Cisco Systems, IBM Europe, Intel, Microsoft Europe, Nokia, Nortel Networks, Philips Semiconductors, Siemens AG, Telefnica S.A. and Thales plus EICTA (European Information, Communications and Consumer Electronics Industry Technology Association), and they worked together and came up with a curriculum scheme known as Career-Space [Career-Space, 2001].

International Federation of Information Processing(IFIP) is an international federation of national computing societies among which ACM and IEEE-CS are part of. It formed a working group, TC3, to conduct a project which was commissioned by UNESCO and the result was a curriculum scheme report ICF-2000 [IFIP, 2007].

3.2 Computing Curriculum Schemes

Mulder et al [Mulder et al., 2004] describes three well-known standard curriculum schemes in the field of CS; CC2001, ICF-2000 and Career-Space. Each of them developed by well-known standard bodied organizations; CC2001 by ACM and IEEE-CS, ICF-2000 by IFIP and Career-Space by a consortium of eleven big ICT firms in Europe. They carried out a comparative study for CC2001, ICF-2000 and Career-Space to critically analysis, compare and judge against relevant guiding principles and characteristic features. The results showed that all the three curricula schemes are good and different in their own sense and that CC2001 has an in-depth level of detail concerning the field of CS than ICF-2000 and Career-Space [Mulder et al., 2002].

There are several objectives of a curriculum scheme as presented by Mulder et al [Mulder et al., 2004]: it is used for re-specifying educational programs, thereby offering guidance to university curriculum developers and decision makers, it is also used by educational management, students, employers and other stakeholders to compare educational programs with respect to their profiles and specific components and also, organizations such as funding bodies, accreditation boards and professional societies may use curriculum schemes as a reference for assessing running educational programs. Hence, Mulder et al derive the definition of a curriculum scheme from the objectives as instruments that may support (re)specification, comparison and assessment of educational programs (curricula). This research study is oriented towards the first and third objectives.

There are three kinds of curriculum schemes; model curricula, curriculum frameworks and curriculum guidelines [Mulder et al., 2004]. The difference between these schemes is that model curricula are schemes with a substantial level of detail and can be implemented as an educational program, with a certain level of flexibility, while curriculum frameworks give a method and a set of rules, conditions and prescriptions in order to be able to develop one's own specific curriculum and curriculum guidelines offers suggestions and recommendations that can support the development of a curriculum [Mulder et al., 2004]. The kind of curriculum scheme that this study focuses on is the model curricula. An example of the model curriculum is the CC2001 [Mulder et al., 2004].

3.3 Background of Computing Curricula series

With the dynamic character of the field of computing, the curriculum is also thus dynamic so as to reflect the changes that have occurred and those anticipated. Therefore efforts to evaluate and re-evaluate the design of a model curricula for programs in computing has been conducted over the years. With specific regards to the efforts of ACM and IEEE-CS in developing the computing curricula series, they started decades ago when there were only a few computing fields, unlike today, and each of these organizations was working separately [Curricula, 2005]. They were investigating the fields of CS and computer engineering and each came up with separate reports.

ACM published curriculum '68, which they later on reviewed and as a result, published curriculum '78, it proposed a standard syllabus for a set of courses that encompassed the core knowledge of CS as a discipline [Curricula, 2001].

IEEE-CS published reports that corresponded to the fields of both CS and computer engineering. They published EC77 report which took a broader view of the discipline, incorporating more engineering into the curriculum and bridging the gap between software and hardware-oriented programs. They later on reviewed EC77 report and as a result published EAB83 report [Curricula, 2001]. (The figures at the end of the reports correspond to the years in which they were published).

Afterwards, in the late 1980s, both organizations saw the need for collaboration and they joined forces and formed a task force to review the curriculum model and as a result the development of the curricula series of reports: CC1991, CC2001, CC2005 etc [Curricula, 2001]. The CC2001 task force also saw the need for producing different reports that were discipline specific and thus there is CC2001 or CS2001 which consist of curriculum guidelines for undergraduate degree programs in CS, CE2004 which consist of curriculum guidelines for undergraduate degree programs in computer engineering, IS2002 which consist of curriculum guidelines for undergraduate degree programs in Information Systems(IS), SE2004 which consist of curriculum guidelines for undergraduate degree programs in software engineering and other reports which are still working drafts that have not yet been officially released like CC2005 which provides an overview of the reports for five defined sub-disciplines of computing: CS, Computer Engineering, Information Systems, IT, and Software Engineering, and IT2005 which consist of curriculum guidelines for undergraduate degree programs in IT [ACM, 2007]. There are other reports that are yet to be produced as the field of computing continues to broaden.

3.4 CC2001 and IT2005 Reports

CC2005 report describes the scope of CS by looking at the work of computer scientists and categorizing them into three categorizes according to what their work entails: they design and implement software, they devise new ways of using computers and they develop effective ways to solve computing problems [Curricula, 2005].

IT is defined in two ways, first in general way, to refer to the field of computing and secondly, with respect to academia, it refers to undergraduate degree programs that prepare students to meet the computer technology needs of application domains through the selection, creation, application, integration and administration of computing technologies [ITcurricula, 2005].

The CC2001 report for CS was developed by a joint task force consisting of members of ACM and IEEE-CS and it was published in 2001 [Curricula, 2001]. IT2005 report is also under the CC2001 series developed by SIGITE a special interest group in ACM for IT computing discipline and it was published in 2005 [ITcurricula, 2005]. Both CC2001 and IT2005 reports follow a similar structure of organization defined by the CC2001 task force [ITcurricula, 2005]. The two fields have different focus areas but they belong to the computing family.

In this chapter I will analyze seven common features that appear in the structure of both reports, which I term as "characteristic features". The characteristic features include: changes in the discipline; guiding principles; structure of the body of knowledge; overview of curricula models; completing the curriculum; professional practice; and characteristics of the graduates. These features will highlight the similarities and differences of the two reports leading to an understanding of the disciplinary approach in curriculum development in CS and IT.

3.4.1 Characteristic features in CC2001 and IT2005 reports

3.4.1.1 Changes in the discipline

The changes that occur at a rapid rate in all fields of computing describes the character of the discipline as being vibrant and dynamic. Both CC2001 and IT2005 acknowledges that changes in advances in technology and social and cultural contexts have affected the respective computing discipline [Curricula, 2001] and [ITcurricula, 2005].

Technological Changes

Much of the change that affects IT comes from advances in technology [ITcurricula, 2005] and [Curricula, 2001]. In chapter two, under technological approach, Webster describes the rise of new technologies as an indicator for an *information society.* Over the last decades new technologies have emerged and some are yet to emerge especially in the areas such as communication, computation, interactivity, and delivery of information which has affected people's work activities and lifestyle [ITcurricula, 2005].
These changes in technology has also affected the discipline's body of knowledge for both CS and IT and has given rise to new topic areas such as the World Wide Web and its applications, networking technologies particularly those based on TCP/IP, systems administration and maintenance, graphics and multimedia, web systems and technologies, service-oriented architecture, e-commerce technologies, relational databases, client-server technologies, inter-operability, technology integration and deployment etc [Curricula, 2001].
Especially for IT, it is the advances in computing communication technology, particularly the Internet and the World-Wide Web, that has given rise to it [ITcurricula, 2005].

Social and Cultural Changes

The cultural and social behavior of people in different context areas are different and it changes with time as new aspects come into being. Technological changes have an effect on the different societies in different context areas and thus affects the CS education in those places.

One of the changes mentioned in both reports is pedagogical changes [Curricula, 2001] and [ITcurricula, 2005]. Networking of computers has enabled new methods of learning to be implemented such as distance learning which gives students flexibility in their studies allowing them to study anywhere and at anytime. Networking has also enabled effective communication and sharing of educational resources between universities in different locations [ITcurricula, 2005]. There are new computer technologies that support learning and hence improving the quality of education. The use of learning tools, demonstration softwares and many others helps the students and teachers in their learning process.

Another change aspect mentioned is the growing awareness and acceptance of computing technologies among the people [Curricula, 2001]. Nowadays, computers can be found in many households and kids start learning about computers as early as possible. Many businesses, firms, governments and households are connected to the internet. This brings about knowledge and skills variance within CS education as there are those students with knowledge and skills about computers and those without because of their different accessibility points to these technologies.

The impact of computing technology to economies is also another change aspect [Curricula, 2001]. Technology has been known to be the tool for development. HEIs are being relied upon to produce skilled and knowledgeable human resource capital in computing technologies to steer-head the job industries in the countries and hence bring about development. The academic discipline of CS has grown widely and new disciplines have emerged to address different areas in computing for instance software engineering, bio-informatics, education technology, IT and many others [Curricula, 2001]. The HEIs in various places are also offering courses to train people in these computing areas and hence addressing the demands of the job industries.

3.4.1.2 Guiding principles

These refers to the guiding principles that led to the development of the CS2001 and IT2005 reports. Below are the similarities and differences of these principles.

Similarities

Both of these reports provide guidance and recommendations for developing a curriculum that strive to be internationally recognized. Every computing curriculum is unique to the institution where the degree program is offered. This is because the curriculum should reflect the needs of both the students and the institution and it should also take into consideration the local societal needs around the institutions [Curricula, 2001]. Although they are different, the are within one educational discipline of computing and hence there should be guidance and recommendations or standards for developing a curriculum that can be recognized internationally but yet unique to its context areas.

They also mention that the guidance and recommendations for developing an undergraduate degree program should be broadly based [ITcurricula, 2005]. Meaning that the reports provide expert views, knowledge and skills in developing an undergraduate degree curriculum in the respective disciplines. The people involved in developing these reports were experts who came from various organizations, institutions and governments. To be successful, the process of creating the recommendations included participation from many different constituencies including industry, government, agencies involved in the creation of accreditation criteria and model curricula, and the full range of higher educational institutions involved in IT education[ITcurricula, 2005].

Both reports agree that the body of knowledge should be made small as possible [Curricula, 2001]. With the vibrant and dynamic character of the discipline of computing, new areas of study within the discipline appear, meaning that new topics should be included in the body of knowledge. With all the changes in the discipline, the reports recommend that the best strategic approach is to reduce the number of topics in the required core so that it consists only of those topics for which there is a broad consensus that the topic is essential to undergraduate degrees [Curricula, 2001].

The reports also mention the required knowledge and skills that all the graduates in the respective computing disciplines should posses [Curricula, 2001] and [ITcurricula, 2005]. The overview report, CC2005, differentiates between the two disciplines of CS and IT by mentioning the career opportunities for graduates in the different disciplines. IT programs exist to produce graduates who possess the right combination of knowledge and practical, hands-on expertise to take care of both an organizations IT infrastructure and the people who use it while CS spans a wide range, from its theoretical and algorithmic foundations to cutting-edge developments in robotics, computer vision, intelligent systems, bio-informatics, and other exciting areas [Curricula, 2005]. Also, by identifying and describing the set of skills that the graduates should have, the curriculum development should be steered towards these skills and hence stability and sustainability of the curriculum.

Both reports go beyond mentioning the required set of courses that is essential for the undergraduate students in the respective computing discipline to also providing recommendations on the implementation strategies that could be used since strategies of implementation of the curricula is equally important [Curricula, 2001]. For instance, in the IT report, it provides institutions with advice on the practical concerns of setting up a curriculum by including sections on strategy and tactics along with technical descriptions of the curricular material [ITcurricula, 2005]. And in the CS report, it mentions that the guidance and recommendations must go beyond knowledge units to offer significant guidance in terms of individual course design by defining a small set of alternative models that assembles the knowledge units into reasonable, easily implemented courses [Curricula, 2001].

Both the reports follow a similar format of development and are part of the computing curricula series. The body of knowledge for each respective computing discipline is organized into three hierarchical levels; Knowledge areas, knowledge units and topics that are within each knowledge unit [ITcurricula, 2005]. The other similarity is that there is a relationship between computing disciplines and thus in IT2005, knowledge units from existing model curriculum documents were used [ITcurricula, 2005].

Differences

One of the differences is that each of the report provide guidelines and recommendations for developing undergraduate curriculum for two different but yet related computing disciplines: CS and IT. The integration of different technologies and the integration of technologies into organizations are fundamental to IT [ITcurricula, 2005]. All CS students must learn to integrate theory and practice, to recognize the importance of abstraction, and to appreciate the value of good engineering design [Curricula, 2001].

3.4.1.3 Structure of the body of knowledge

The structure of the body of knowledge for both CS and IT are divided into three hierarchical levels: Knowledge areas, knowledge units and topics.
Knowledge areas are subfields within the discipline. There are 14 knowledge areas in CS and 12 knowledge areas in IT. Figure 3.2 and Figure 3.3 shows the knowledge areas in the two disciplines. The knowledge areas are identified by two letter abbreviations and with the case of IT, a three letter abbreviation is also used.

Discrete Structures (DS)	Human-Computer-Interaction (HC)
Programming Fundamentals (PL)	Graphics and Visual Computing (GV)
Algorithms and Complexity (AL)	Intelligent Systems (IS)
Architecture and Organization (AR)	Information Management (IM)
Operating Systems (OS)	Social and Professional issues (SP)
Net-Centric Computing (NC)	Software Engineering (SE)
Programming Languages (PL)	Computational Science and Numerical Methods (CN)

Figure 3.2: The 14 Knowledge Areas and the respective knowledge units in the CS Body of Knowledge [Curricula, 2001]

Within the knowledge areas, there are knowledge units which are thematic modules of the area [Curricula, 2001]. The units are identified by two letter or three letter abbreviation of the knowledge areas followed by a number and they are further divided into topics which is the lowest level in the hierarchy [ITcurricula, 2005].

Social and Professional Issues (SP)	Programming Fundamentals (PF)
Networking (NET)	Platform Technologies (PT)
Information Assurance & Security(IAS)	Information Management (IM)
Human Computer Interaction (HCI)	Web Systems and Technologies (WS)
Systems Administration & Maintenance (SA)	System Integration & Architecture (SIA)
Integrative Programming & Technologies (IPT)	Information Technology Fundamentals (ITF)

Figure 3.3: The 12 Knowledge Areas and the respective knowledge units in the IT Body of Knowledge [ITcurricula, 2005]

Core and Elective Courses

One of the principles guiding the development of the reports was about keeping the core courses as minimal as possible. The core courses here refers to those courses that are compulsory for all undergraduate students taking a degree in either CS or IT. The task force developing both reports define the core as those units for which there is a broad consensus that the corresponding material is essential to anyone obtaining an undergraduate degree in this field [Curricula, 2001]. While the elective courses are those additional courses from the body of knowledge that is optional for the students to take in addition to the core courses. The core courses does not constitute a whole curriculum, additional courses to support it must also be studied [Curricula, 2001].

In Appendix A, Table 1 shows the CS body of knowledge with the core units underlined and the total core unit hours for each area. And Table 2 shows the IT body of knowledge with the core units underlined and the total core unit hours for each area.

3.4.1.4 Overview of the curricula models

The structure of the curriculum model is designed in such a way that it reflects the levels in which the courses appear in the curriculum. It is divided into three levels. Introductory level which consists of entry-level courses offered in the first and second years of the undergraduate studies to introduce the students to the field, intermediate level which consist of courses offered in the second and third year of undergraduate studies to build a foundation for the students in the field for further studies and advanced level which consist of courses offered in the later years of the study, for the undergraduate studies case, it's the fourth year and it usually requires knowledge and skills from earlier courses [Curricula, 2001].

The structure of the curricula models is independent of the courses termed as either core or elective [ITcurricula, 2005]. These courses can be taught at any level of the curriculum depending on the institution's objectives although the first and second year consists of most core courses.

Implementation Strategies

In addition to the curricula models, there should be implementation strategies on how to implement the curricula models. The curricula models by themselves does not constitute a whole curriculum, thus the reports, CC2001 and IT2005, proposes some implementation strategies that has worked and could be used to implement the curricula models [Curricula, 2001].

The implementation strategy that can be used for CS discipline at each level is shown in Figure 3.4. CC2001 gives detailed information about each strategy.

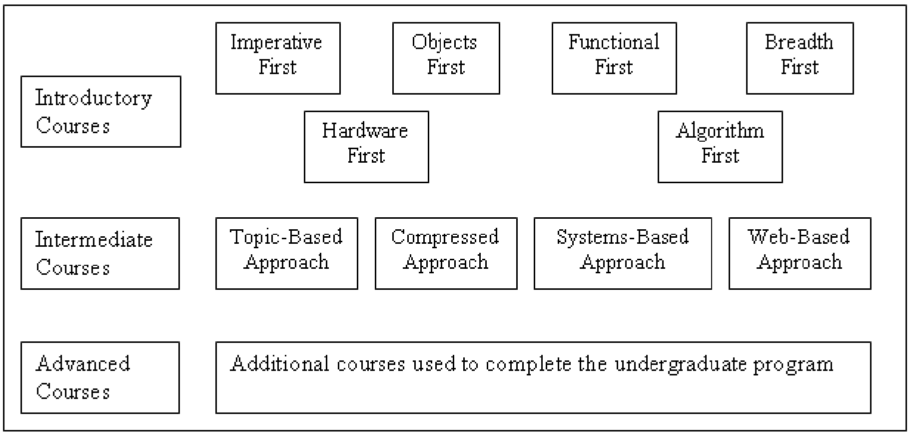


Figure 3.4: Introductory, intermediate and advanced curriculum model levels and the implementation strategies that can be used in each level. [Curricula, 2001]

While the implementation strategies that can be used for the IT discipline includes practicum first, theory first, core or integration first and pillars first [ITcurricula, 2005]. Although the IT2005 report does not mention at which level which strategy is appropriate, it explains clearly what is involved when implementing each strategy.

The practicum first approach, just by its name, it gives the students in the field the required practical experience earlier in the curriculum and it is appropriate for those institutions offering internships to students earlier in their studies for instance after their second year studies [ITcurricula, 2005].

The theory first approach provides the students in the field with the necessary theoretical background about the discipline first then followed by the practical experience. The committee of the IT2005 report recommend a hybrid of practicum first and theory first to be very effective [ITcurricula, 2005].

The core or integration first approach covers in detail most of the core courses from the body of knowledge in the field early in the curriculum [ITcurricula, 2005].

And the pillars first approach introduces the detail of the IT pillars first and provides the integration later in the curriculum [ITcurricula, 2005].

3.4.1.5 Completing the curriculum

In addition to the body of knowledge, structure of the curricula models and implementation strategies that constitute a curriculum, the task force also outlines a set of general requirements that support the broad education of students in both IT and CS disciplines [Curricula, 2001].

These general requirements include:
Knowledge in Mathematics

It is important for the computing students to have knowledge in mathematics because of the relationship between mathematics and computing discipline. Both CS and IT borrow some of the techniques and formal reasoning from mathematics [ITcurricula, 2005] and [Curricula, 2001]. For instance, functional programming and problem solving draw directly upon the mathematical concepts and notations for functions; algorithmic analysis depends heavily on the mathematical topics of counting, permutations and combinations, and probability; discussions of concurrency and deadlock draw heavily from graph theory; and both program verification and computability build upon formal logic and deduction and many more [Curricula, 2001].

Both reports recommend that the mathematical courses should be included in the early levels of the curriculum and they also recommend mainly on mathematical courses in the areas of discrete mathematics and statistics in addition to the other relevant mathematic courses [Curricula, 2001].

Knowledge in scientific methods

It is also important for the students to possess knowledge in scientific methods. The scientific methods consists of a basic methodology for much of the whole realm of computing, and it includes data collection, hypothesis formation and testing, experimentation, analysis [ITcurricula, 2005].

The task force of both reports recommends that with regards to scientific methods the students should develop an understanding of the scientific method and experience this mode of inquiry in courses that provide some exposure to laboratory work and that they should also acquire their scientific perspective in a variety of domains, depending on program objectives and their area of interest [Curricula, 2001].

Application domains

There are many application areas in our societies in which computing technologies, knowledge and skills can be applied and used effectively. Therefore the computing students should have an in-depth knowledge of these application areas and an understanding of how the computing technologies can be used and applied in those areas [Curricula, 2001].

Thus, for the students to understand the application domains and the application of the computing technologies, knowledge and skills to these domains, the task for recommends two approaches that could satisfy this. one by integrating case studies with CS or IT programs and the other by providing internships for students to gain knowledge and understanding in work environments [Curricula, 2001].

Communication Skills

Communication skills is very important in our everyday lives and therefore computing students should have these skills in order for them to communicate and work effectively in their work places and also in general. The reports lists a number of communication skills that the students should have, such as communicating ideas effectively in written form, making effective oral presentations, both formally and informally, understanding and offering constructive critiques of the presentations of others and thus it recommends that the curricula should have course work that emphasizes the mechanics and process of writing, formal oral presentations giving opportunities for constructive criticism [Curricula, 2001].

Team Work Spirit

In organizations and other different work places, people work together in order to run the businesses of the companies and organizations, hence developing team work spirit is important. Software projects as well as IT projects are usually implemented by groups of people working together as a team [Curricula, 2001]. Therefore students in these computing disciplines should learn how to work together as a team.

The task force of both reports hence recommends that the curriculum should have courses and projects that require the students to work together as teams [ITcurricula, 2005].

3.4.1.6 Professional Practice

CS and IT programs train their students to be professionals and therefore learning professional practices is very important requirement for the students. The need to incorporate professional practice into the curriculum is based upon real-world issues, such as the needs of the public and private sector, the publics demand for higher quality products, the increasing number of software liability cases and the need to promote life-long learning after graduation and hence awakening and broadening the students'mind and interest in computing [Curricula, 2001].

Working in organizations, business firms and companies requires a certain way of personal conduct and qualities. It includes communication skills, teamwork spirit and interpersonal skills in collaborating with workmates and clients, honesty, integrity, motivation and strong work ethics and analytical skills [Curricula, 2001].
By learning about these practices and ethics related to the field of computing, the students will be able to join companies and adjust smoothly without the sense of isolation that young professionals often feel and be well equipped to practice their profession in a mature and ethical way [Curricula, 2001].

The reports suggest ways in which professional practice can be integrated into the curriculum so that the student may learn about them as early as possible. They mention that which ever way it is added to the curriculum, it should be emphasized more through the course exercises, projects and exams [Curricula, 2001].
An example given on integrating professional practice is by including in the introductory courses, discussions and assignments on the impact of computing and the Internet on society and the importance of professional practice or additional material, such as computer history, techniques for tackling ill-defined problems, teamwork with individual accountability, real-life ethics issues, standards and guidelines, and the philosophical basis for ethical arguments. This may be covered either in a ded-

icated course or distributed throughout the curriculum [Curricula, 2001].

3.4.1.7 Characteristics of the graduates

The characteristics of the graduates in the computing field largely depends on the objectives of the curriculum implemented [Curricula, 2001]. Curricula that are software engineering oriented would likely steer the students towards becoming software engineering professionals and those that offer a wide variety of courses in different areas of the computing field would likely prepare their graduates to be flexible and adapt to any computing profession easily.

CS is a large field of study and degree programs in this field vary in a broad sense depending on the institution's objectives and needs. For instance, institutions might offer degree programs that provide opportunities for students to take courses on a wide range of topics spanning the entire area of CS, or alternatively, offer programs that take one very specific aspect of CS and cover it in great depth, thus depending on the degree programs, graduates would be equipped with knowledge and skills portraying characteristics related to the program [Curricula, 2001].

One of the characteristics of the graduates in CS is that they should be able to apply their theory knowledge into practice. They must understand not only the theoretical underpinnings of the discipline but also how that theory influences practice [Curricula, 2001].

The graduates of the field of CS must also understand aspects of computer systems and have practical experience in software project development. They must develop a high-level understanding of systems as a whole and must be involved in at least one substantial software project [Curricula, 2001].

IT programs are more specialized than the CS programs and thus graduates in these programs are trained to be specialists in the field of IT. Fundamental to IT is the integration of different technologies and the integration of technologies into organizations [ITcurricula, 2005].

IT2005 reports describes some characteristics that relates to the field of IT. An example of these characteristics is that the graduates of this field must be able to meet the needs and requirements of their clients. IT graduates must therefore develop a mind-set that does not allow losing focus on the importance of users and organizations [ITcurricula, 2005].

Since the field of IT is about integration of technologies to organizations, the graduates of this field must be well conversant with the technologies that are present and how they are used. They must be able to identify and evaluate current and emerging technologies and assess their applicability to address the users needs and also analyze the impact of technology on individuals, organizations and society, including ethical, legal and policy issues among others [ITcurricula, 2005].

Since the running of businesses and organizations are mainly based on the transactions of information, those businesses and organizations that are technology oriented should have their security issues ensured. Since if the security is breached and the organization's information is tempered, it may cause the organization to collapse, hence security is very important. IT graduates must therefore have knowledge and skills on the security of technologies and hence prevent certain organizational risks [ITcurricula, 2005].

Both reports describe that the graduates must be able to adapt accordingly as the field of computing continues to evolve [Curricula, 2001]. They must possess a solid foundation that allows them to maintain their skills as the field evolves [Curricula, 2001]. Hence, they must therefore develop life-long learning habits [ITcurricula, 2005].

Chapter 4

Five universities in five countries as case examples

The sub-Saharan region of Africa is a big part of Africa and consists of several countries. In this research, focus will be on HEIs in the following sub-Saharan African countries: Kenya, Tanzania, Uganda, Namibia and South Africa.

Figure 4.1 shows countries in the African continent and their locations. The Equator cuts right across Kenya and Uganda. Tanzania borders Kenya and Uganda at the North of it's borders and Namibia and South Africa are at the south of the African Continent. Kenya, Uganda and Tanzania are located at the eastern part of the continent while Namibia and South Africa at the southern part. Uganda is a land-locked country while the other countries, kenya, Tanzania, Namibia and South Africa borders water bodies Indian Ocean and Atlantic Ocean as shown in the map. In the following sections, I will briefly discuss on the background information of the five countries and the institutions included in this research study.

4.1 Kabarak University in Kenya

Kenya covers an area of 582,646 sq km [CBOS, 2005]. The bordering countries are Uganda, Tanzania, Sudan, Ethiopia and Somalia. It also borders the Indian ocean at the North-East of the country as shown in Figure 4.1. The Kenyan population is 36,913,721 million people as according to 2007 estimates and its growing [CBOS, 2005]. The official languages used are English and Swahili and there are other many native languages spoken for instance Kikuyu, Kalenjin, Luo etc. The majority of the kenyan people are Christians and then the muslims but there are other small indigenous beliefs practiced at some places [CBOS, 2005]. Kenya got it's independence from the British colony in the year 1963 and the first president was Mzee Jomo Kenyatta [Embassy of Kenya, 2006]. The capital city of kenya is Nairobi.

Figure 4.1: A map showing countries and their locations in the African continent [Map of Africa, nd].

Kenya uses the 8.4.4 educational system which comprises of eight years in primary school, four years in secondary school and at least four years in HEI [KIE, 2003]. There are an increasing number of HEIs in Kenya, both public and private to cater for the increasing number of people seeking higher education. There are six stated-owned national universities and thirteen private universities of which, Kabarak University which is under-study, is one of them [KHC, 2006].

The ICT sector in Kenya has been growing over the years and it is still growing as some parts of the country are yet to grow in this sector. The National ICT policy was produced in January 2006 and it aims to improve the livelihoods of Kenyans by ensuring the availability of accessible, efficient, reliable and affordable ICT services [Ministry of Infomation Communication, 2006]. Figure 4.2 shows the status of ICT infrastructure in kenya according to the years shown.

The broad challenge of ICT for national development in Kenya is to harness the

Indicator	
Telephone lines (2005)	281,800 (2005)
Mobile telephones (2006)	4,612,000 (2006)
Internet users(3.1% of the population)	200,000 and 1,054,900 (2000 & 2006)
Internet hosts	13,274 (2006)
Television broadcast stations	8 (2002)
Radio stations	24 AM; 18 FM (2001)

Figure 4.2: The table shows ICT Infrastructure Status in Kenya in the respective years [Farrell, 2007a].

potential of ICTs for economic growth and poverty reduction and one of the specific challenges mentioned in the policy is human resource development which relates to the educational sector [Ministry of Infomation Communication, 2006]. The Government recognizes the role played by the various institutions providing ICT education and training and thus it strives to strengthen this areas through various ways including promoting ICT in education at primary, secondary, tertiary and community levels by developing ICT curricula and ensuring that teachers/trainers possess the requisite skills [Ministry of Infomation Communication, 2006]. Also, it will set up a framework for evaluating and certifying ICT training programmes, establish networks for sharing training resources and developing strategies to support research and innovation [Ministry of Infomation Communication, 2006].

Kabarak University

It is a Christian-based private university in Kenya that was started in 2000 by the former President Moi. He is the founder and chancellor of the University [Kabarak, 2007]. The university is not yet fully chartered; it operates under the letter of Interim Authority granted by the Kenyan government to allow the institution to award degrees. Both the vision and mission statement of the university portrays an international perspective of the institution. The vision is to become an international center of learning in science, technology and business enterprise and the mission is to provide holistic quality education to the youth as well as other age groups, equipping them with knowledge, practical skills and Christian moral values necessary for the service of God and humanity. It serves the local communities, the nation and the world through the creation, preservation and dissemination of knowledge, within the context of Biblical Christianity [Kabarak, 2007].

The University has a five schools and three campuses. Among the schools, is the school of Science, Engineering and Technology which houses three departments, department of Computing, Maths and Physics, department of Environment and Life Sciences and the department of Engineering and Telecommunication

[Kabarak, 2007]. The school offers a number of undergraduate degree programs in CS, Physics, Chemistry, Mathematics, Botany and Zoology [Kabarak, 2007].

4.2 Makerere University in Uganda

Uganda is a land-locked country whose bordering countries are Kenya, Tanzania, Rwanda, Sudan and Democratic Republic of Congo as shown in Figure 4.1. It is the smallest country among the countries under research in this study with an area of 236,040 sq km [CIA, 2007d]. Uganda has a population of 30,262,610 million people as according to the 2007 estimates and the majority are of the Christian faith[CIA, 2007d]. The capital city of Uganda is Kampala. It got its independence in the year 1962 from the British colony and the first president was Sir Kabaka Edward Muteesa2 [my Uganda Country Portal, 2008]. The official language in Uganda is English, Luganda is widely spoken among the Ugandan people [CIA, 2007d]. The educational system being used in Uganda is that of seven years in primary school, followed by four years in lower secondary school, then two years in upper secondary school and a further three to five years at the university level [my Uganda Country Portal, 2008]. Uganda has a number of Universities in the country, Makerere University, one of the oldest and biggest is among these universities [my Uganda Country Portal, 2008].

As any other developing country, the ICT sector in Uganda is growing with time. The national ICT policy was developed in 2003 [Farrell, 2007b]. Among the objectives of the policy, the second objective is about ICT literacy and capacity building in which the the government intends to carry out a number of activities. They include focusing on the integration of ICT into all educational curricula and developing and managing technical training within schools, business/industry and international institutions by promoting private-public partnerships that encourage repatriation of international-based Ugandan ICT professionals and establishing incentives for capacity development for all sectors of society [CommunicationInitiative, 2007a]. Figure 4.3 shows the status of ICT infrastructure in Uganda as according to the years shown.

Makerere University

Makerere University, which is in Uganda, is one of the oldest universities in Africa. It was established in 1922 as a technical school, Uganda Technical College. It then expanded to become a center of Higher Education in East Africa in 1935 and in 1937 it developed into an institute of higher education offering post-school certificate courses. In 1949, it became a University College affiliated by the University of

Indicator	
Telephone main lines (per 1,000 people)	3 (2000) , 3 (2004)
Mobile subscribers (per 1,000 people)	16 (2000), 45 (2004)
Population covered by mobile telephony (%)	16 (2000), 70 (2004)
Internet users (per 1,000 people)	2 (2000), 6 (2004), 18 (2006)
Personal computers (per 1,000 people)	3 (2000), 5 (2004)
Households with television	5 (2000), 6 (2004
VSAT providers	8 (2006)
Mobile cellular operators	3 (2006)
Private FM stations	145
Private TV stations	34

Figure 4.3: The table shows ICT Infrastructure Status in Uganda in the respective years [Farrell, 2007b].

London and in 1963 a University of East Africa and cutting its ties with the University of London. Later on in 1970, Makerere University became an independent University of the Republic of Uganda [Makerere, 2007].

The University has in total twenty two academic units, 11 faculties, 6 institutes and 5 schools offering a wide range of research, undergraduate and postgraduate programmes, for both day and evening classes. The Vision and Mission statements of the university are to be a center of academic excellence, providing world-class teaching, research and service relevant to sustainable development needs of society and providing quality teaching, carry out research and offer professional services to meet the changing needs of society by utilizing World wide and internally generated human resources, information and technology to enhance the University's leading position in Uganda and beyond respectively [Makerere, 2007].

Among the faculties, is the faculty of Computing and IT which provides students with knowledge, skills and expertise in this new technology world and it offers a number of programs including Doctoral Programs, Masters Programs, Bachelor's and Diploma Programs and short courses [Makerere, 2007].
It also has four departments, department of CS, department of IT, department of Networks and department of Information Systems. The objective of the department of CS is to develop professionals with theoretical and practical skills in CS and build a management capacity with a practical orientation needed to link up the CS sector with the industries and it runs two undergraduate degree programs one of which is BSc(CS) [Makerere, 2007].

4.3 Tumaini University in Tanzania

Tanzania is located in the Eastern part of Africa. It is the largest of the three East African countries; Kenya, Uganda and Tanzania, with an area of 945,087 sq km [CIA, 2007c]. It borders Kenya, Uganda, Rwanda, Republic of Congo, Burundi, Malawi, Zambia, Mozambique and the Indian Ocean as shown in Figure 4.1. The country's population as according to the 2007 estimates is 39,384,223 million people [CIA, 2007c]. Dar es Salaam are the country's capital city [CIA, 2007c]. The official languages spoken in Tanzania are Swahili and English. There are other many languages spoken too in different regions in the country for instance Arabic is mostly spoken in Zanzibar [CIA, 2007c]. Both Christian and Muslim faith are widely followed in the country about 30 Percent and 35 percent respectively. The other indigenous beliefs are about 35 percent too [CIA, 2007c]. Tanzania got it's independence in the year 1964 from the British colony and the first president was Mwalimu Julius Nyerere [AfricanAmericanRegistry, 2005].

The United Republic of Tanzania notices the importance of quality education to the country's national development. The educational system in Tanzania is slightly similar to that used in Uganda. It is based on the 7-4-2-3 system [Mwenegoha, nd]. It has three levels: Basic, Secondary and Tertiary. It comprises of two years of pre-primary Education, seven years of Primary Education, four years of Junior Secondary (Ordinary level), and two years of senior secondary education (Advanced level) and up to three or more years of Tertiary Education [Tanzania, 2007].

Higher education in Tanzania is under the Ministry of Higher Education Science and technology. There are a number of HEIs in the country, both public and private. Public Universities in the country are listed in the Ministry's website [Msthe, 2007]. Tumaini University, Iringa University College is one of the private universities in Tanzania.

With the support of international organizations, International Institute for Communication and Development(IICD) and Swedish International Development Agency (SIDA), initiatives to integrate ICT into the educational sector have been started with the formulation of 11 educational projects [Hare, 2007]. The benefits of the projects to the educational sector in the country lead to the development of the ICT policy for Basic education in 2007 by the Ministry of Education and Vocational Training [Hare, 2007]. The Figure 4.4 shows the status of the ICT infrastructure in the country.

Indicator	
Telephone lines	138,227 (2006)
Mobile phone subscribers	5.7 million (2006)
Internet users	333,000 (2005)
Television stations	29 (2006)
Internet hosts	8609 (2006)
Radio stations	47 (2006)

Figure 4.4: The table shows ICT Infrastructure Status in Tanzania in the respective years. [Hare, 2007]

Tumaini University, Iringa University College

Tumaini University, Iringa University College (IUCO) in Tanzania is the youngest of the Tumaini University schools which was established in 1993 [ELCT, nd]. It is a Christian-based foundation and its mission statement is to engage its faculties and students in studies of higher learning committed to the pursuit of truth through scientific research and inquiries and also to promote higher education in its broadest sense delving into fact-finding under the guidance of and in obedience to the Word of God [ELCT, nd].
IUCO has four faculties currently; faculty of Arts and Social Sciences, faculty of business and economics, faculty of Law and faculty of Theology [IUCO, 2007]. It is the first private university in Tanzania to offer Bachelors Degree in 1995 [TumainiUniversity, 2007].

4.4 University of Namibia in Namibia

Namibia is located in the South-West of the African continent. It borders the Atlantic Ocean, South Africa, Botswana, Angola and Zambia and it covers an area of 825,418 sq km [CIA, 2007a]. The capital city of the country is Windhoek and its population as according to July 2007 estimates is 2,055,080 [CIA, 2007a]. English is the official language and Afrikaans is widely spoken by the majority of the population. There are other native languages too like Oshivambo, Hehero, Nama etc [CIA, 2007a]. With respect to religious beliefs, majority of the Namibian population are Christians, they contribute to almost 80 percent to 90 percent of the population while the other beliefs contribute to 20 percent to 10 percent of the population [CIA, 2007a]. The country got its independence early in the 1990 [CIA, 2007a].
Primary education in Namibia is compulsory for children between ages 6 and 16 and it is also free of charge for those schools managed by the state government. According to chapter 3 article 20 of the constitution of the republic Namibia, these children are not allowed to leave school until they have completed their primary

education or have attained the age of 16 and that private investors can invest in the educational sector as long as they follow the standards and guidelines given in the constitution [Namibia, 1998]. The educational system comprises of seven years of primary education, three years of junior secondary education after which, according to the student's performance in the national exam, the student may either continue to the senior secondary education for another two years and afterwards higher education [Isaacs, 2007a].

Indicator	
Fixed-line subscribers	127,900 (2004)
Mobile subscribers	495,000 (2005)
Internet users	75,000 (2004)
Television broadcast stations	8 (plus about 20 low power repeaters (1997)
Radio stations	AM 2; FM 39;shortwave 4 (2001)

Figure 4.5: The table shows ICT Infrastructure Status in Namibia in the respective years. [Isaacs, 2007a]

Namibia has a number of initiatives aimed at improving, among other sectors, the educational sector in the country through the integration of ICT. It has an ICT policy for Education adopted in 2003 which was developed in 1995 and revised in 2002 [CommunicationInitiative, 2007b]. Figure 4.5 shows the ICT infrastructure status in Namibia.

The Policy's objectives are to produce ICT literate citizens, to produce people capable of working and participating in the new information and knowledge-based economy and society, to leverage ICT to assist and facilitate learning for the benefit of all learners and teachers across the curriculum, to improve the efficiency of educational administration and management at every level from the classroom, school library, through the school, and on to the sector as a whole and to broaden access to quality educational services for learners at all levels of the education system and set specific criteria and targets to help classify and categorize the different development levels of using ICT in education [Isaacs, 2007a].

University of Namibia

It is the only university currently in Namibia and it was established in 1992. The founding Chancellor of the University is Dr Sam Nujoma, who is also the first President of Namibia [UNAM, 2007]. The Vision and Mission statements of the University are to engage with society in the creation and dissemination of knowledge, through teaching, research and advisory services, and a commitment to life-long learning and to engage in socially and nationally relevant, academic and technical training, research and educational programmes with the involvement of all stakeholders in a conducive environment for learning, innovation, knowledge creation, professional development, functional skills development and development related competencies, within the cultural context of the Namibian people respectively [UNAM, 2007]. The University has seven faculties, four campuses and eight regional centers. The faculty of science has eight departments among which is the department of Computing [UNAM, 2007]. There are a number of degree programs being offered under the department of Computing, BSc(Special in population and Development), BSc(Engineering), BSC in any two major subjects like Environmental Biology, Chemistry, CS, Geology, Mathematics, Statistics, Physics and other courses from other faculties [UNAM, 2007].

4.5 University of Pretoria in South Africa

South Africa is the largest of the countries under study with an area of 1,219,912 sq km [CIA, 2007b]. It borders the coastlines of two great oceans, Atlantic Ocean and Indian Ocean. The country is located at the South most corner of the African continent and it borders the following countries; Namibia, Botswana, Lesotho, Mozambique, Swaziland and Zimbabwe as shown shown in Figure 4.1. It has three capital cities, Pretoria which is its administrative capital city, Cape Town which is its legislative capital and Bloemfontein which is the judicial capital city and the 2007 population estimates of the country were 43,997,828 [CIA, 2007b]. The country got it's independence in the year 1910 from the British colony and the first president was president Nelson Mandela [CIA, 2007b].

The Constitution recognizes 11 official languages, namely Afrikaans, English, isiNdebele, isiXhosa, isiZulu, Sependi, Sesotho, Setswana, siSwati, Tshivenda and Xitsonga [GCIS, 2007]. The other languages spoken include Khoi, Nama and San languages, sign language, Arabic, German, Greek, Gujarati, Hebrew, Hindi, Portuguese, Sanskrit, Tamil, Telegu and Urdu [SouthAfrica.infor, nd]. With respect to religion, the majority of South African population follows the Christian faith and the rest are either Muslims, Hindus, Jews, Buddhists and others [GCIS, 2007]

South Africa's educational system consists of three broad bands: general education and training, further education and training and higher education and training [SouthAfrica.info, 2006]. The general education and training consists of the basic pre-primary and primary education level and the further education and training consists of secondary education and the higher education and training consists of

university education. There are twenty one public universities in South Africa of which university of Pretoria is among them.
Figure 4.6 shows the status of ICT infrastructure in South Africa in the year 2005.

Indicator	
Fixed-line subscribers	4.7 million
Mobile subscribers	23.1 million
Dial-up subscribers	1.08 million
Broadband subscribers	165,290
Internet users	3.6 million
Television broadcast stations	556
Radio stations	AM 14; FM 347

Figure 4.6: The table shows ICT Infrastructure Status in South Africa in 2005 [Isaacs, 2007b]

University of Pretoria

The University of Pretoria in South Africa is one of the leading and largest universities in the African continent [UP, 2007]. It ranks fourth in African universities and seven hundred and two in the world [CyberMetricsLab, 2007]. It was first established as the Transvaal university college in 1908 and in 1930 it became the University of Pretoria [UP, 2007]. The university has currently more than fifty thousand students, inclusive of those learning through distance learning and international students [UP, 2007]. The University has a number of visions and mission statements. One of it's vision is to be a leader in Higher Education that is recognized internationally for academic excellence, with a focus on quality and one os it's Mission statements is to provide excellent education in a wide spectrum of academic disciplines [UP, 2007]. It also has seven Campuses in operation and a number of faculties and a business school(Gordon Institute of Business Science). The faculties are further sub-divided into either schools or departments. The faculty of Engineering, built Environment and Information Technology is sub-divided into schools among which is the School of Information Technology and it has three departments, CS, Informatics and Information Science [UP, 2007]. The department of CS's main objective is to explore and research the scientific basis of new technologies and to promote the proliferation of reliable, robust and innovative computing and information technologies into the IT industry in South Africa [UP-CS, 2008]. The department offers two degree programs BSc(IT) and BSc(CS) which provide fundamental software skills and professional values to the graduates to enable them develop software-based solutions to problems in a variety of context [UP, 2007].

Chapter 5

Research Design and Methodology

This chapter looks at the approach taken in conducting this study. As already described in chapter one, the scope of the study, entails comparisons of CS or IT degree curricula to an international standardized curriculum model CC2001 or IT2005 respectively. The aim is to find out the reliability of the respective institutions' curriculum in both the adherence to the general guidelines and standards of the discipline of CS and IT and its role in serving the needs of the society around the institutions, thus standards verses context sensitivity.

5.1 Research Design

The research approach carried out in this study is qualitative research. There are various definitions given of qualitative research. Creswell defines qualitative research as one where the inquirer often makes knowledge claims based primarily on constructivist perspectives (i.e the multiple meanings of individual experiences, meanings socially and historically constructed, with an intent of developing a theory or pattern) or advocacy(participatory) perspectives (i.e political, issue-oriented, collaborative or change oriented) or both [Creswell, 2002].

This definition is appropriate because the study makes knowledge claims based on the multiple meanings of the individual experiences and also from socially and historically constructed meanings to understand the CS or IT degree curricula implemented in institutions in SSA. Therefore, in order to achieve this understanding, constant interactions with the field of study and people through various methods such as interviews, observations and analysis of existing documents is important [Merriam, 1998]. These methods leads to the collection of a wide variety of data [Yin, 2003]. By employing inductive research strategy, meanings, concepts, theory and abstracts are deduced from the underlying data and the product will be richly descriptive from a small, non-random and purposeful sample [Merriam, 1998].

Therefore, the design approach of this study is appropriate because it involves studying CS and IT degree curricula implemented in different social and context areas and yet belong to the computing discipline. It also involves studying how they serve the needs of their context areas and yet follow the guidelines and standards of the field of computing.

There are several perspectives in which knowledge claims can be based on, examples of these perspectives discussed in literature are positivism, postpositivism, critical theory, constructivism, participatory in [Denzin and Lincoln, 2005].
With regards to this study, it claims knowledge through the constructivism perspective. Creswell discusses this perspective as where assumptions are made when individuals seek understanding of the world they live in and work and develop subjective meanings of their experiences which are directed towards certain objects or things [Creswell, 2002]. Similarly, interpretive perspectives attempts to understand phenomena through the meanings people assign to them and hence, constructivism is often combined with interpretivism [Creswell, 2002].

Therefore, constructivism perspective is appropriate for this study because I seek to understand the influence of the CS and IT degree curricula implemented in different social and cultural context areas to its surrounding and on the other hand its adherence to the guidelines and recommendations of degree curriculum development in CC2001 and IT2005 reports respectively. I also seek to understand the issues involved within CS and IT degree curriculum, what factors are taken into consideration during the development of the curriculum in respective institutions and what makes these curricula different from each other.

5.2 Research Methods

Multiple -Case Study

The method of inquiry employed in this research is multiple case study. Where the case being studied is the CS or IT degree curriculum in five different universities in SSA as described in Chapter 4.

Merriam [Merriam, 1998] discusses several descriptions given by different researchers of a case study but she points out one defining characteristic of the method which is the case study research lies in delimiting the case. She supports Stake in his description of a case study as a bounded system or integrated system. Examples of cases include student, program, community, society and teachers among others. Merriam also describes intrinsic case studies as those studies selected because they are intrinsically interesting and she also clarifies the description by giving an example of studying a college counseling program for returning adult students [Merriam, 1998].

Therefore the choice of the multiple case study method for this research is because the case being studied is a bounded system which lies within either CS or IT degree curriculum which is implemented differently in five Universities in SSA. Figure 5.1 describes the multiple case study method in this research.

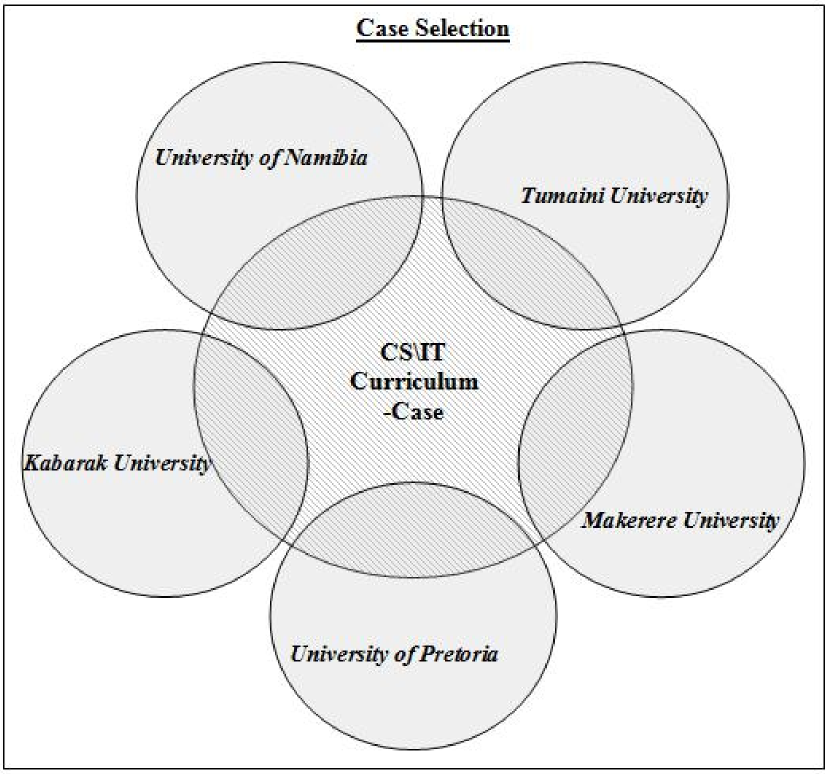


Figure 5.1: CS or IT curriculum is a common element amongst the five university cases although it is implemented differently in each university.

There are five specific techniques for analyzing case studies discussed in detail by Yin and they include pattern matching, explanation building, time-series analysis, logic models and cross-case synthesis, therefore, for analyzing this case study, the technique used will be cross-case synthesis because it is especially suitable for multiple case studies [Yin, 2003], and the process will originate from the research questions. Analysis of case data will be first done for each university where the case is implemented and then a cross-case analysis of the case data.

Case Selection

When selecting a case to be studied a number of factors has to be taken into consideration. Factors such as organization of Issues involved in the study, contexts, strategies, case selection, interactivity of the issues, data gathering, triangulation among others [Denzin and Lincoln, 2005]. Stake discusses that we choose a case as according to what we can learn the most out of it and hence the primary criterion is opportunity to learn [Denzin and Lincoln, 2005]. Merriam supports this by explaining that the decision to focus on qualitative case studies stems from the fact that this design is chosen precisely because researchers are interested in insight, discovery and interpretation rather than hypothesis testing [Merriam, 1998].

Therefore, selection of a case for my research study is shown in Figure 5.1. A common element among the five university cases as shown is CS or IT degree curriculum, however, each university case implements its own degree curriculum differently mainly because of the objectives and goals of the institutions. The fact that this study is about examining of CS or IT degree curricula implemented in five universities to investigate its extent in adherence to the guidelines and recommendations in CC2001 or IT2005 respectively and its extent in responding to the contextual needs of its surrounding, is the reason for my choice of it as the case to be studied since it provides an opportunity to learn the most out of it.

Case contents

A case study has some form of conceptual structure and it involves contexts and organizing issues around the case which is used to deepen understanding of the specific case [Denzin and Lincoln, 2005]. Basing on the research questions mentioned in chapter 1, Figure 5.2 shows the issues involved within the case. The issues involved include courses, students, faculty or the department of CS, context, curriculum development and institutions. There are also sub-issues within each issue which shows the relationship between the issues and hence provide a deeper understanding of the case. The issues describe the activities that revolve around the CS curriculum in an institution.

The characteristic feature of this case study is both particularistic and descriptive [Merriam, 1998]. Particularistic in that the focus is on only the CS or IT curriculum and descriptive in that the result of the case study is a rich, thick description of the case. In studying the case, Stake explains that the work has to be reflective and this requires the researcher to dig into meanings, working to relate contexts and experience and hence interactivity of the issues involved [Denzin and Lincoln, 2005].

Therefore, as shown in Figure 5.2, the faculty or department of CS or IT offer degree programs within its respective fields, it states requirements needed in order to do the degree programs and also to graduate, and it organizes graduation of the students of its department. The department or faculty of CS also has projects conducted either for research purposes or for developmental purposes and it involves both the staff and students of the department. They also have the responsibility of developing and implementing the curriculum. The development of the curriculum is done by a team of selected qualified people who will follow the necessary standards, objectives of the institution and an international standard curriculum in order to developed a working curriculum. The courses in the curriculum are studied by the students of that department including other departments in the institution. They can either be core, which requires all students in the program to do it or elective, which is optional for the students.

The students, who are the beneficiaries of the program gain knowledge and skills that are necessary for them to continue with further education or join the the job market and in the long run give back to their societies through their work. The institutions provides resources and facilities to enable teaching and learning to take place. They are strategically located within societies or context areas in which they serve through either different developmental and educational projects, production of knowledgeable and skilled human resource and contribution to the country's economy etc and hence participate in nation building.

Societies are the context areas in which the institutions are embedded. There are different elements that constitutes a society including the social and cultural values, historical settings, geographical areas, resources, politics and governance systems, economies, the job industry and educational systems among others. And since educational institutions are part of the societies, the running of the institutions is affected these different elements and thus the development and implementation of the CS curriculum.

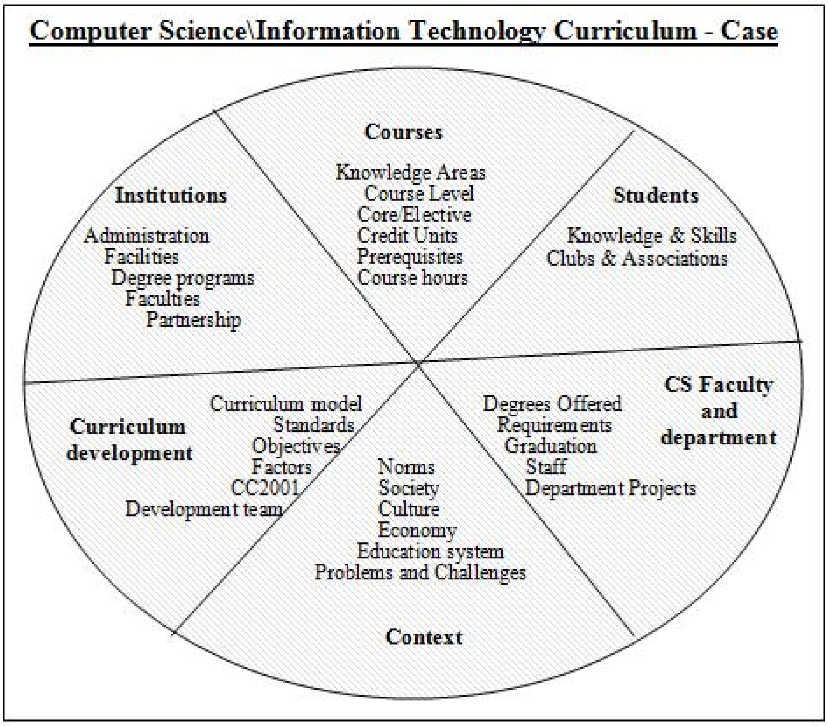


Figure 5.2: Issues involved within CS or IT curriculum case study.

5.3 Data Collection Methods

The data collection methods that I have employed are interviews and documents. Stake explains that the details of life the researchers are unable to see for themselves are obtained by interviewing people who did see them or by finding documents recording them [Denzin and Lincoln, 2005].

5.3.1 Telephone and E-mail Interviews

The reason for choosing a telephone and(or) e-mail interview as a data collection method for this research is, one for obvious reasons that i would get immediate feedback and hence have a discussion on the topic, secondly, because of the geographical boundary between the interviewees who were located in different locations and i, thus saving on time and cost. And also, by interviewing people with an in-depth knowledge about this area of study, it will give me a better understanding of the case study.

The interview questions(Appendix B) are based around the research questions and are categorized under two broad themes: curriculum; curriculum and local needs. The type of interview conducted was structured interviews because all respondents were asked the same series of pre-established questions with a limited set of response categories [Denzin and Lincoln, 2005].

5.3.2 Documents

Creswell gives advantages of using documents as a method of collecting data among which is that it can be accessed at any time convenient to the researcher and that it represents data that are thoughtful [Creswell, 2002]. Using relevant documents in a research study to collect data has an equivalence to using interviews or observation as a method of data collection [Merriam, 1998]. Therefore, in addition to the interview method, a comprehensive review of documents with information about the respective universities CS or IT curriculum, international standards regarding the academic discipline of CS and IT, application areas where computing knowledge are applicable and information about higher education and its impacts were carried out.

5.4 Research Validity and Reliability

In his book, Yin explains in detail on this concept of the criteria used for judging the quality of research designs [Yin, 2003]. He also describes the four tests used and they include construct validity, internal validity, external validity and reliability [Yin, 2003].
In this section, i will vote for the credibility of the quality of my research using three of the above tests.

5.4.1 External and Construct Validity

External validity deals with the problem of knowing whether a study's findings are generalizable beyond the immediate case study. The fact the this is a multiple-case study research proves this test. The study involved studying cases of five different Universities in SSA.

Construct validity involves establishing correct operational measures for the concept being studied [Yin, 2003]. It involves establishing a precise procedure to be be followed and identification of the objects to be studied. For this research study, the operational measures started from the research questions which kept the study in focus. Figure 5.1, Figure 5.2 shows the case studied and the issues revolving around the case as well as the overall picture of how the case study was conducted.

Participants Profile

The participants involved in this study are people from the university cases in the faculties or departments under which CS or IT degree programs are offered and who have relevant information and knowledge about their curriculum. They also have got high level of educational background in the field of computing and some hold high job positions in their respective institutions thus, they have long experience in the computing field and information collected from them is valuable. They were also involved in either the development, review or implementation of the CS or IT curriculum. Thus the questions they were asked were relevant to their knowledge in either CS or IT degree curricula.

Interview Process

The telephone interview process started in the week of 21st January 2008 by first sending an email message to the departments of CS in the universities under study to identify the participants and at the same time, asking them for their willingness to participate in this study. The email message also described what the research study is about and how it relates to them. The participants were also informed of their voluntary participation in the research study and that all individual data would be confidential and anonymous.

Upon receiving positive feedback from the first three Universities, the participants and i scheduled the appropriate interview dates and times convenient for them. I also sent the key interview questions prior to the interview date so that they would be informed on the areas we would be discussing on and also for their own preparation purposes.

The first interview session was conducted on the 28th of January 2008 with the participant from Tumaini University. The interview session lasted for about 20-25 minutes. The second interview was conducted the next day, 29th of January with the participant from Kabarak University in Kenya and it lasted about the same time with the previous interview session. The third interview was conducted the following day, 30th of January with the participant from Makerere University and and it lasted slightly more than the two previous interviews (about 3o mins). In each interview sessions, the same questions were asked leading to a discussion on different various issues about their degree CS or IT curricula.
Equally the same, the other participants from the remaining institutions opted to answer the interview questions emailed to them prior to scheduling of the interview

dates and emailed their responses back to me and hence the email interview survey.

After both kinds of interview sessions, a follow-up was done via electronic mail for clarification and elaboration of some areas in the data collected that were not clear. Figure 5.3 shows the number of participants i interviewed and the number of participants whom we communicated via email.

Documents Validity

Yin discusses four types of the method of triangulation. They include data triangulation, investigator triangulation, theory triangulation and methodological triangulation. The method of triangulation that best suits this study is data triangulation as it involves triangulation of different data sources [Yin, 2003]. There were multiple data sources used to collect data for the literature review of this study. There are references in the earlier Chapters for the sources of data used.

Sources for data concerning the universities understudy

Institution	No. of Participants	Mode of Interview	Degree programs	Document type	Document Sources
Kabarak University	1 2	Telephone E-mail	Bsc.CS	Curriculum Document University's website	Infcrmant Web-document
Makerere University	1 1	Telephone E-mail	Bsc.CS Bsc.IT	Undergraduate Handbook University's website	Infcrmant Web-document
Tumaini University	1 1 1	Telephone E-mail Face-to-face	Bsc.IT	Undergraduate Handbook Curriculum document University's website	Infcrmant Web-document
University of Namibia	1 1	Telephone Email	Bsc.CS	Undergraduate Handbook University's website	Infcrmant Web-document
University of Pretoria	0 1	Telephone Email	Bsc.CS Bsc.IT	University's website	Web-document

Figure 5.3: These are sources of data concerning the universities example cases and their degree curricula for the degree programs they offer. The sources were also used to gather data concerning other issues related to the curriculum.

The type of data collected from the data collection methods and their sources as shown in Figure 5.3 included but not limiting, background information of the institutions, degree programs offered in the respective universities especially CS and IT, courses offered within the cs and it degree programs, course description of the courses offered in the curriculum, organization of the curriculum for cs and it degree programs.

An undergraduate handbook is a book that acts as a manual guide to students, teachers, administration and interested people and it contains information concerning the historical background of the institutions, its mission and vision, the services it offers, the programs implemented, the outcomes expected among other kinds of information. Handbooks are usually written or developed by the institutions and given to the students inquiring about the institution and its services or those joining the institution to familiarize themselves with the programs they have enrolled it and its curriculum. Within these handbooks, the information relevant to this study included the undergraduate degree programs of either CS or IT and its curriculum in the respective universities, the background history of the institutions, the activities and services run by theses institutions, projects among others. Chapter four contains the background information of the institutions under study. The informants in 5.3 are the participants who participated in this study by providing relevant information from their respective universities.

In this technology and electronic age, universities have the information in their handbooks transformed in electronic forms. These information can be accessed via the universities'websites. Hence, in this research study, i also accessed the respective universities' websites to get information about the degree programs offered in those institutions and their respective curricula, especially for CS and IT degree programs as shown in Figure 5.3.

The information in the universities' respective websites can be trusted because it is always updated with the current activities. Unlike the handbook which does not reflect current activities taking place in the institutions, unless the degree programs have changed or the curricula have changed, which usually occurs after a number of years.

5.4.2 Reliability

Reliability is important in any research study as the objective is to be sure that if a later investigator followed the same procedures as described by an earlier investigator and conducted the same case study from the begining, the investigator should be able to arrive at the same findings and conclusions [Yin, 2003]. Yin mentions that one way to approach reliability problem is to make as many steps operational as possible and to conduct research as if someone is always looking over your shoulder and in order to do this, he mentions the use of the case study database [Yin, 2003].

Therefore in my research, i vote for the reliability of this study in accordance to the following operational steps followed. As stated in the thesis statement i aim at finding the balance between standards and contextual sensitivity during curriculum development and implementation of the undergraduate degree programs of CS and IT.

The two research questions in Chapter one were derived from the thesis statement to facilitate for the comparative analysis of the degree curricula of the university cases in order to investigate the thesis statement. Hence, all the steps followed in conducting this research started from the research questions.

I first started by doing a background literature review of degree curriculum development of CS and IT fields. The information revolved around the HEIs that offer degree programs in CS and IT, the context areas of these institutions, the contextual needs of the institutions and the roles of the institution in addressing these needs. Literature review on the available standard models, international guidelines and recommendations for the development of the degree curricula was also done. Chapters two, three and four contains more information about this literature review.

The research design and methodology approach chosen was qualitative research of a multiple-case study. I then selected the case to be studied and identified the issues revolving around the case. Figure 5.1 and Figure 5.2 describes the case selection and the identification of the case issues clearly.

The methods of data collection used were telephone and e-mail interviews and documents analysis. The explanation concerning the choice of data collection methods are explained in the data collection methods section 5.3. Figure 5.3 documents the sources of information and the type of data that was collected. Prior to the interview sessions with the participants, i sent email messages to ask for their willingness to participate in this research study.

After receiving positive feedback from them, i then scheduled telephone interview dates and time with the participants at their convenience. I also sent the interview questions prior to the dates of the interview questions so that the participants would prepare on the areas we would be discussing about. For some participants, they responded to these questions by sending an email message with the answers to the questions and thus the e-mail type of interview. And for the others we held the telephone interview discussions on the agreed upon dates. I then did a follow-up of both discussions via a number of email messages or telephone discussions.

After data collection, i thoroughly went through the data collected and extracted meaning and information from them. I organized the information collected in categories or themes derived from the interview questions asked to the participants and the answers given by them. These categories resulted to the formation of the case study database and its structure (See Appendix C).

I then embarked on the data analysis of the cases' data according to the categories forming the database. This resulted to the categorical data analysis of each single cases. This first analysis led to an in-depth understanding of the case in each institution under study and it also answered research question one. Chapter six elaborates more on this analysis.

The second analysis was the comparative analysis of the cases in the case study database to the characteristic features of CC2001 and IT2005 and also to the role of the HEIs in the five perspectives of an *information society*. This comparative analysis led to answering of the research question two and achieving the purposes of the research study. Chapter seven has more details for this second analysis.

I then finally drew on the conclusions and recommendations of this research study as described in Chapter eight.

Chapter 6

Case study database and categorical data analysis of curricula

In this chapter, I will first present the findings of the case in each university in a tabular format, based upon the themes or categories formed from the questions asked to the participants and the answers given by them. This presentation will constitute my case study database(See Appendix C). I will then analyze each case data from each university case as according to the categories that structure the case study database hence single -case data analysis. The analysis will highlight the similarities and differences between the curricula models in each institution and as a result deepen the understanding of the issues around each institution's curriculum. It will also answer the first research question of this study as presented in chapter one. The following ten categories thus presents the analysis of each case data from the case study database.

1. **Curriculum development and review**
   This category revealed a number of factors. First, there is the background information of the degree programs in their respective university cases as shown in Figure 6.1. Secondly, information concerning the review of the curriculum and the reasons for reviewing it as shown in Figure 6.2 and thirdly, the factors taken into consideration during either the development or review of the curriculum which is shown in Figure 6.3.

University	Background Information
Makerere University	The faculty of Computing Information and Technology houses two degree programs in computer science and information technology. These programs started in the year 2001 and 2002 respectively. The developers of the first curriculum were people with some kind of qualifications in the discipline of computing and mathematics and admission to the programs were open.
Tumaini University	Offers degree program in Information Technology. The program has recently been started in September 2007 and earlier before the commencing of it, general courses were offered. The development of the degree curriculum model involved several stakeholders.
Kabarak University	The computer science degree program in this institution is housed in the department of computing under the school of information communication and technology. The development of the computer science curriculum was done by a few selected people from other universities within the country who compared the development of the curriculum to their own institutions' computer science curriculum and hence developing a hybrid of it. The degree program was first started in 2002.
University of Namibia	The faculty of science houses the computer science degree program. The department of computer science offers along with the degree in computer science, a minor in statistics, mathematics or economics. The degree program was designed so as to provide the country the much needed human resource capital in the area of computer science.
University of Pretoria	The school of Information Technology houses the department of Computer Science which offers undergraduate degree programs in both computer science and information technology.

Figure 6.1: Background information of the curriculum model of each institution studied.

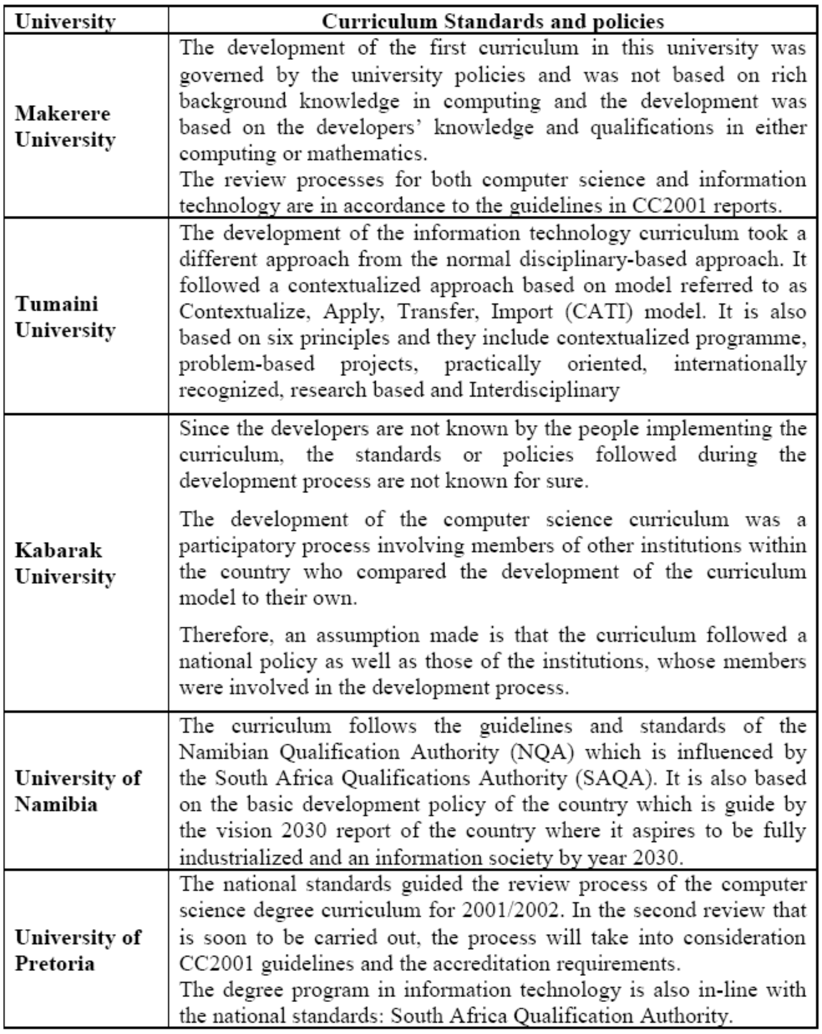
University	Curriculum review and reasons
Makerere University	The first curriculum review was done for Computer Science degree program in accordance to CC2001 guidelines and the implementation of it started by 2006. The review for Information technology degree program is still under process and it is also in accordance to CC2001 guidelines. The reasons for reviewing the computer science degree program included streamlining the computer science discipline and therefore training the students to have the right knowledge and skills in the field, to accommodate research orientation and revise the initial admission requirements and also to facilitate for the graduates to be accepted in other institutions.
Tumaini University	Since the program was started recently, it is still establishing roots in the institution and therefore a review has not been carried out yet.
Kabarak University	The review of the computer science curriculum is under process. The reasons for reviewing the curriculum include accommodating change since the field is dynamic and creating the university owned curriculum since the initial one was developed by outsiders.
University of Namibia	The first review of the computer science curriculum has been carried out and the implementation started in February 18th 2008. The reasons for reviewing the curriculum included determining the department's level and how the curriculum fits the international standards.
University of Pretoria	The degree curriculum for computer science was reviewed for 2001/2002 and is about to be reviewed for year 2009. The degree curriculum for information technology was reviewed in 2005 and implementation started in 2006. Before review of the degree curriculum of information technology, the graduates specialized in either: Computer Science; Computer Systems and Information and Knowledge management. After review, Information and knowledge management remained

Figure 6.2: Information concerning review of the curriculum in each institution and the reasons for the review.

University	Development or Review factors
Makerere University	There a number of factors taken into consideration during the review process and they include industrial expectations, pure academic discipline and collaborations between universities
Tumaini University	The development of the Information technology degree curriculum in Tumaini University took the local society and the local IT industry needs into consideration.
Kabarak University	The use of the available facilities in the institution and the much needed knowledge and skills in the job market.
University of Namibia	The review factors of the computer science curriculum included the following, financial and human resources implications; timetable and venue implications; yearbooks and student promotions implications; program design and stakeholders of the University.
University of Pretoria	Industry and the institution: So that students can either join the job industry or pursue further education.

Figure 6.3: Information concerning factors taken into consideration during development or review of each institution's curriculum model.

2. **Curriculum standards and policies**
This category contains guidelines, standards or policies which guided the development of each institution's degree curriculum. It answers the first research question of the study which is about the standards followed by the institutions during the development of their respective curricula models. Figure 6.4 presents the standards in each university case.



University	Curriculum Standards and policies
Makerere University	The development of the first curriculum in this university was governed by the university policies and was not based on rich background knowledge in computing and the development was based on the developers' knowledge and qualifications in either computing or mathematics. The review processes for both computer science and information technology are in accordance to the guidelines in CC2001 reports.
Tumaini University	The development of the information technology curriculum took a different approach from the normal disciplinary-based approach. It followed a contextualized approach based on model referred to as Contextualize, Apply, Transfer, Import (CATI) model. It is also based on six principles and they include contextualized programme, problem-based projects, practically oriented, internationally recognized, research based and Interdisciplinary
Kabarak University	Since the developers are not known by the people implementing the curriculum, the standards or policies followed during the development process are not known for sure. The development of the computer science curriculum was a participatory process involving members of other institutions within the country who compared the development of the curriculum model to their own. Therefore, an assumption made is that the curriculum followed a national policy as well as those of the institutions, whose members were involved in the development process.
University of Namibia	The curriculum follows the guidelines and standards of the Namibian Qualification Authority (NQA) which is influenced by the South Africa Qualifications Authority (SAQA). It is also based on the basic development policy of the country which is guide by the vision 2030 report of the country where it aspires to be fully industrialized and an information society by year 2030.
University of Pretoria	The national standards guided the review process of the computer science degree curriculum for 2001/2002. In the second review that is soon to be carried out, the process will take into consideration CC2001 guidelines and the accreditation requirements. The degree program in information technology is also in-line with the national standards: South Africa Qualification Authority.

Figure 6.4: Procedures or policies or guidelines followed during development or review of each institution's curriculum model.

3. **Curriculum objectives**
This category presents the objectives that orients the implementation of the curricula models. Figure 6.5 presents the different objectives of the curricula models in the respective university cases.

University	Curriculum Objectives
Makerere University	To develop professionals with theoretical and practical skills in Computer Science. To strengthen capacity and institutional building in Computer Science in tertiary institutions, the private and public sectors. To build a management capacity with a practical orientation needed to link up the Computer Science sector with the Government and Industry under the broader perspective of computing and ICT. To provide most of the computing and ICT professionals needed by the Ugandan market and neighbouring countries.
Tumaini University	To enable students to identify early enough the societal expectations from technology. To train students to take up any IT related jobs in the country. To enable the students to continue with graduate education in computing. To ensure the program contributes positively to the local community
Kabarak University	Train highly motivated world-class programmers, computer Scientists and software engineers. Provide IT professionals to staff in local IT-oriented organizations. Provide IT professionals with an entrepreneurial outlook and the capacity to create viable business ventures that embrace computing as a tool. Create a pool of IT professionals capable of defiling the future direction of this country's IT industry. Provide the graduate with high-technology skills to improve their employability and potential for economic impact. Create young professionals with a commitment to excellence, high productivity, and social responsibility. Provide basic training for those wishing to take up postgraduate programmes in Information Technology. Create a centre of excellence in Information Technology at Kabarak University.
University of Namibia	To enable students who would like a single major in Computer Science and hence contributing to the national effort towards self sufficiency in human resources in the field of computing.
University of Pretoria	The main objective of the department is to explore and research the scientific basis of new technologies and promote the proliferation of reliable, robust and innovative computing and information technologies into the IT industry in South Africa. Earlier objective of computer science degree curriculum was to produce graduates with relevant knowledge for the IT industry in the world but nowadays the objective more towards the fundamental issues in computer science for accreditation purposes. The objective of the information technology degree program focuses on the industry related trends, providing wider background, additional niche and better job opportunities.

Figure 6.5: A table showing the degree curriculum objectives in the respective universities.

4. **Curriculum challenges and problems**
This category presents the challenges and problems faced by the university cases during the development and implementation of their respective curricula models. There are two Figure tables, Figure 6.6 shows the challenges and problems faced during development of the respective institution's curriculum and Figure 6.7 shows challenges and problems faced during the implementation of the respective institution's curriculum model.

University	Curriculum development challenges and problems
Makerere University	During the development process, there was lack of human resources with adequate background knowledge in curriculum development and implementation. The institutions' decision makers were not so much conversant with the field of computing.
Tumaini University	Building a rapport and an understanding with the university implementing the curriculum since the researchers are not original from the context area. Financial issues and the fear that the research will just be one of those research studies that end up being documented in the libraries. The challenge that the curriculum being developed should be internationally recognized.
Kabarak University	Since the developers were not originally from the staff of the university, the problems and challenges faced were during the implementation of the curriculum.
University of Namibia	The guidelines did not have enough details as to what should be included in the curriculum. Limited resources and financial problems. They had to compromise between timetabling of the courses and the capacity of the laboratories and lecture rooms.
University of Pretoria	Working within the parameters of the accreditation requirements as the goal of the curricula is striving for international accreditation.

Figure 6.6: These are the challenges and problems faced by the institutions during the development of their respective degree curriculum models.

University	Curriculum implementation challenges and problems
Makerere University	The university policy stated that curriculum review was to be done after four year and though with the identification of some problems in the curriculum the department had to wait until four year has elapsed. The institutions 'resources' capacities were being strained because of the growing number of the students in the department.
Tumaini University	The challenges faced or experience during implementation so far are in the areas of pedagogy in encouraging independent work and how to address automatic computation in a form that is understandable to the students, curriculum design in establishing a meaningful and logical order of course work and outreach because there are no established connections with the local community.
Kabarak University	They are faced with the challenge of interpreting the objective of some courses in the curriculum. Some courses in the curriculum are becoming outdated and obsolete. And also misplacement of some courses in the curriculum as some that should be in the introductory level are in the intermediate or advanced level and vice versa Shortage of full-time lecturers to take up courses in the curriculum and hence the present lecturers are overwhelmed with courses to lecture and also since the institution has three semesters in one academic year, the lectures do not have time to relax.
University of Namibia	Timetabling of the curriculum and synchronizing it with the other departments' timetables that offers some courses from the computer science department.
University of Pretoria	Working within the parameters of the accreditation requirements as the goal of the curricula is striving for international accreditation.

Figure 6.7: These are the challenges and problems faced by the institutions during the implementation of their respective curriculum models.

5. **Curriculum organization**
This category contains information on the structure of the body of knowledge for each institution, the structure of the curricula models implemented in the institutions and implementation strategies of the curricula models. Figure 6.8 describes the implementation process of the curricula models in each institution. Figure 6.9 presents information of the structure on the body of knowledge in the curricula models of the university cases. Figure 6.10 shows the structure of the curricula models of the degree programs in the university cases.

University	Curriculum Organization
Makerere University	**Program Duration** Lasts for 3 academic years **Learning Experience (**15crswk+2examwk=17 Semesters**)** Lecture/contact hours, tutorial hours and practical hours **Examination process** Assessment tests every sixth period and the examination after 15th week. And assignments given by lecturers. **Practical experience** After 1st year = 10 weeks of practical skills After 2nd year = 10 weeks of industrial attachment After 3rd year = Industrial project work
Tumaini University	**Program Duration** Lasts for 3 academic years **Learning Experience** Lecture hours, practical hours, on-line distance learning, assignments, discussions and group works. **Assessment process** Examinations = 50% tests = 25% and practical assignments = 25% **Practical experience** Practical sessions and industrial attachments
Kabarak University	**Program Duration** Lasts for 4 academic years **Learning Experience** Lecture hours, course work presentations, assignments, tutorials and practical hours **Assessment process** Examinations and continuous assessment tests. Pass mark 60% **Practical experience** Practical lab sessions and industrial attachments
University of Namibia	**Program Duration** Lasts for 4 academic years **Learning Experience** Lectures hours and laboratory sessions or tutorial hours. **Assessment process** Examinations = 50% and Assessment tests = 50% for both full and half modules. In addition, two tests and assignments. **Practical experience** Lab sessions, Industrial attachments and software development projects.
University of Pretoria	**Program Duration** Lasts for 3 academic years **Learning Experience** Assignments, Examinations, lectures, class discussions, practical sessions **Assessment process** Examinations, tests, assignments. **Practical experience** Practical sessions

Figure 6.8: This table shows how the curriculum is organized in terms of its implementation in each institution.

University	Curriculum Structure of the body of knowledge
Makerere University	**BSc(Computer Science):** The structure of the body of knowledge for the degree program in computer science in this institution is available in their institution's website. Appendix H contains the structure of the body of knowledge for CS curriculum model. More information can be accessed from this link http://www.cit.ac.ug/cit/curricullum.php?program=4. The information was retrieved on 10th March 2008. **BSc(Information technology):** The structure of the body of knowledge for the degree program in Appendix H also contains contains the structure of the body of knowledge for IT curriculum model. More information is also available in their website and it can be accessed from this link http://www.cit.ac.ug/cit/curricullum.php?program=1. This information was also retrieved on 10th March 2008.
Tumaini University	**BSc(Information technology):** See Appendix F for the structure for the body of knowledge for Information Technology degree program in this university.
Kabarak University	**BSc(Computer Science):** See Appendix E for the structure of the body of knowledge for Computer Science degree program in this University.
University of Namibia	**BSc(Computer Science):** See Appendix G for the structure of the body of knowledge for Computer Science degree program in this University.
University of Pretoria	**BSc(Computer Science) and** **BSc IT(Information and Knowledge Systems)** The structure of the body of knowledge for the degree program in computer science and Information Technology in this institution is available in their institution's website. For both degree programs, the structure of the body of knowledge is contained in Appendix I. More information can be accessed from the link below from pages 136 to 153. http://web.up.ac.za/sitefiles/File/yearbook_2008/ Information%20Technology%202008%20_28%20Jan.pdf. The information was retrieved on 10th March 2008.

Figure 6.9: This table shows the difference in the structure of body of knowledge of the degree curricula models in the institutions.

University	Structure of the Curricula Models
Makerere University	**BSc(Computer Science) and BSc(Information technology):** The structure of curriculum model for both Computer Science and Information Technology degree programs consisted of core and elective modules throughout the three years academic period. See Appendix H for the structure of the curricula models. Kindly refer to the University's website on the links below for more information. http://www.cit.ac.ug/cit/curricullum.php?program=4 and http://www.cit.ac.ug/cit/curricullum.php?program=1
Tumaini University	**BSc(Information technology):** The structure of the curriculum model for this degree program consists of core and elective modules. See appendix F for more details.
Kabarak University	**BSc(Computer Science):** The structure of the curriculum model for this degree program consists of University modules, core and elective modules. See Appendix E for more details
University of Namibia	**BSc(Computer Science):** The structure of the curriculum model for this degree program consists of University modules, core and elective modules. See Appendix G for more details.
University of Pretoria	**BSc(Computer Science) and BSc IT(Information and Knowledge Systems)** The structure of the curriculum model for these degree program consists of fundamental modules, core and elective modules. Appendix I contains the structure of the curricula models for both programs in this institution. Kindly refer to http://web.up.ac.za/sitefiles/File/yearbook_2008/Information%20Technology%202008%20_28%20Jan.pdf. For more details concerning the structure of the curricula models for these degree programs.

Figure 6.10: This table shows the difference in the structure of the curricula models of the degree programs in each institution.

6. **Curriculum specialization and uniqueness**
   This category shows the difference in the university cases' curricula models in their areas of specialization and in their uniqueness as shown in Figure 6.11.

University	Curriculum specialization and uniqueness
Makerere University	**Specialization** Databases, networking and telecommunication and software engineering. **Uniqueness** It has industrial focus and its open to international collaborations
Tumaini University	**Specialization** professionalism **Uniqueness** The practicality nature of the curriculum and the curriculum's focus on the needs of the society around the institution.
Kabarak University	**Specialization** Software engineering **Uniqueness** Compulsory Bible courses Good infrastructure and computer facilities
University of Namibia	**Specialization** Tendency towards databases and software engineering **Uniqueness** Nothing particularly unique.
University of Pretoria	**Specialization** Oriented towards the areas of the research groups in the department: Computational Intelligence, Distributed Systems, Security and Software Engineering and Automata. **Uniqueness** BSc(IT) is unique as it focuses the studies in particular application domains while BSc(CS) as it is possible to do double majors in computer science.

Figure 6.11: This table shows the different areas in which the curriculum model for each institution is oriented towards.

7. **Curriculum benefits**
   This category describes the benefits brought about by the degree curriculum model to its institution and the society. Figure 6.12 shows these benefits of the curricula models.

University	Curriculum Benefits
Makerere University	Field attachment programs bring about the interaction between the students and the job industries. Entrepreneurship programs for both Information Technology and Computer Science. Soft skill programs such as communication skills, literacy, languages make the curriculum to be responsive to the local environment.
Tumaini University	It's neither too theoretical oriented nor practically oriented. The adoption of problem-solving approach seems to be working well; both the students and teachers like it. It seems to encourage the students to take initiative in problem solving situations.
Kabarak University	The curriculum covers a wide range of topics in computer science thereby creating a solid grounding for students in all areas especially in the early stages. In the latter stages, students are given a chance to specialize in areas they feel more comfortable in. This creates more motivation on the side of the student as they enjoy what they are studying. The provision of industrial attachment is also an advantage as it gives practical skills to students and enhances their learning experience. Provision of non-computer courses (common core courses) such as communication & study skills, bible courses etc.
University of Namibia	The benefits of the curriculum are derived from integrating theory and practice so that the modules in the curriculum provides the concepts, skills, tools, and techniques required for addressing the needs of the society.
University of Pretoria	The benefits are derived from the purposes of the modules in the degree curricula models.

Figure 6.12: Benefits of the curriculum to each institution.

8. **ICT related societal needs**
   This category presents the examples given by the participants of study concerning the needs of the society related to ICT in their context areas. Figure 6.13 presents these examples.

University	ICT related societal needs
Makerere University	The need for ICT for facilitating government programs in Uganda. Exploitation of ICT opportunities in Uganda and the neighbouring countries
Tumaini University	As the curriculum is still young and one of the objectives being early identification by the students of the societal needs that can be addressed by technology, the students are currently conducting a fieldwork study to identify these needs in the society.
Kabarak University	Communication systems Farming, marketing of products Transport system
University of Namibia	The need to develop and deploy application software for various problem situations. The need to improve the management of IT systems. The need to properly manage software engineering problems.
University of Pretoria	The ICT related needs of South Africa.

Figure 6.13: Examples of the local needs related to ICT in the University cases.

9. **Recommendations**
   This category presents the participants' own views concerning curriculum development (See Appendix C) in CS and IT and about additional requirements that should be taken into consideration in order to improve the quality of their own degree curricula models. Figure 6.14 presents the various views given about this category (See next page).

10. **Balance between standards and societal needs**
    This category also contains the participants'own views concerning where the balance is achieved during development of the degree curriculum model in CS or IT. The balance is between following the disciplinary standards in curriculum development and meeting the local society needs. Figure 6.15 shows the participants' own views in the respective institutions.

University	Curriculum Recommendation
Makerere University	Establish partnership with the industries to inform on what is lacking in the curriculum. Standardization of the programs. Establish research programs that will bring in money to the university. Should look at CC2001 model hence uniformity? There should be clear cut definition between CS and mathematics.
Tumaini University	A heavier emphasis on e-learning should be put. It can have very positive and productive outcomes for very small investments. Encourage ICT4D and also interdisciplinary.
Kabarak University	Collaborations between universities and companies. Curriculum review should be done regularly in collaborations with the IT industry. Entrepreneurship courses should be included into the curriculum.
University of Namibia	More involvement of the University of Namibia in information related activities to reach people that are rural based.
University of Pretoria	Ethical values to be instilled to the graduate of the degree programs so that they can be ethical members of the society in their professions.

Figure 6.14: Recommendations concerning additional requirements to the curricula models.

University	Balance between international standards and local needs
Makerere University	The departments should strike the balance by customizing the standard model to the local society needs. The customizations should be done in view of the standard model so that it is towards the local society needs but the background of the discipline should remain the same.
Tumaini University	It is important to have the local stakeholders in the Iringa region to first identify their needs both explicitly and implicitly through conducting studies and projects in the region. They should also materialized and understand the international standards in the field of computing as something that can have impact in the local society.
Kabarak University	–
University of Namibia	The current curriculum needs a lot of modification to reach the standards that have been suggested in the CC2001 guidelines as the level entry to university education in Namibia is a bit low. The university is therefore introducing preliminary courses that will prepare the students to the entry level into the field of computer science as in accordance to CC2001 guidelines.
University of Pretoria	With the aspects of globalization and IT, international standards would be required a basis for measurement.

Figure 6.15: Recommendations concerning the balance between international standards and local society needs in curriculum development.

Chapter 7

Standards and contextual sensitivity in curricula

This chapter will analyze the cases' data from the single -case analysis by comparing them to the characteristic features of CC2001 and IT2005 reports and also to the the role of HEIs in the society from five perspectives as defined by Webster: A cross-case analysis. The analysis will answer research question two of this study and it will also answer the purpose of the study as it is described in the thesis statement in chapter one.
Figure 7.1 presents an overall picture of the data analysis process in this chapter.

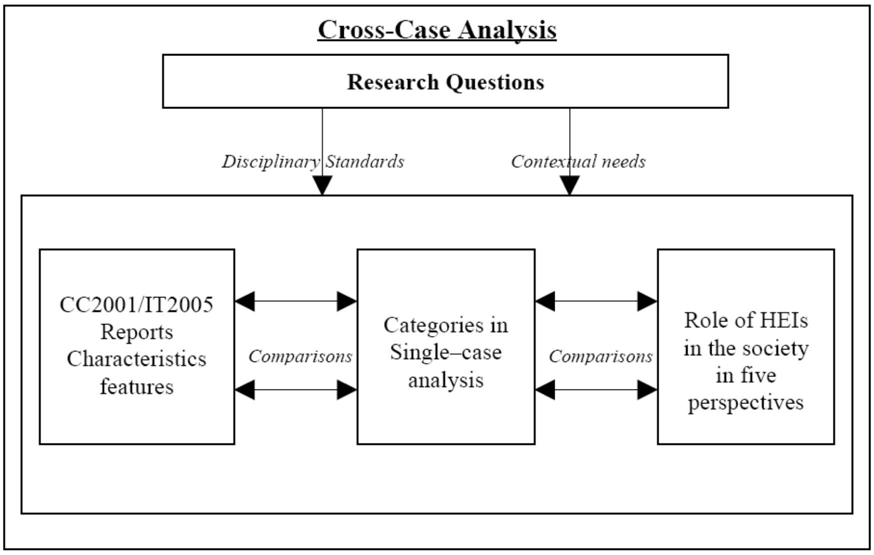


Figure 7.1: Overview of the cross -case analysis process in this chapter.

7.1 Compliance of curricula to CC2001 and IT2005 reports

This section will compare the categories from the single -case analysis to the characteristic features of the CC2001 and IT2005 reports governing the development of undergraduate degree curricula in CS and IT respectively as shown in Figure 7.1. The comparisons will reveal the extent in which the university cases' curricula models comply to the discipline's international guidelines in degree curriculum development regardless of the universities' individual standards that they followed.

1. **Changes in the discipline**
   As already described in Chapter three, technological, social and cultural changes brings about changes in the discipline of CS and IT. These changes also affect the academic aspect of the disciplines. These changes in the academic aspect of the discipline include technological-supported pedagogical methodologies, the growing body of knowledge of the discipline and also effective means of communication.

   The pedagogical methodologies exercised by the university cases are described within the curriculum organization category. There are some similarities in their methodologies especially with the normal traditional lecture hours, lab sessions, practical sessions, assessment process and industrial attachments etc. The difference comes out especially when they exercise the practical sessions and the industrial attachments. For instance, the degree curricula for CS and IT implemented in Makerere University, conducts ten weeks of practical skills at the end of each academic year. This ensures that the students are well equipped with the practical skills needed.

   The changes in the discipline brought about by the rise of new technologies results to the growth of the body of knowledge for both CS and IT degree programs. This growth will therefore lead to the review or revision of the degree curricula so that the changes can be accommodated. The review will ensure that the students are kept up-to date with the latest technologies that are being researched on. The curriculum review process in most of the institutions under study have been carried out and the reasons given for the review process are mainly towards providing the students with the right knowledge and skills in the disciplines. The curriculum development and review category in the previous chapter provides more information about the review of the curricula in the respective institutions.

By making use of the technologies during development and implementation of the degree curricula models, it will help overcome some challenges and problems faced by the institutions. The category curriculum challenges and problems lists some of the problems faced by the respective institutions during the development and implementation of their curricula. Therefore some of these problems can be solved by the use of technologies or by the facilitation of it. For instance, the problem of shortage of staff can be solve by employing distance learning in the institution.

The use of technologies improves the means of communications within and outside the institutions. This facilitates for collaborations between the universities and industries and these leads to sharing of resources, knowledge and facilities etc. Some of the curriculum benefits in the same category highlights on the collaborations between universities and also with the IT industries.

2. **Guiding principles**
   The development of CC2001 and IT2005 reports were guided by a set of principles. Likewise, the development of the individual institutions'curriculum model was guided by a set of standards or policies. The category curriculum standards and policies in the previous chapter highlights on these standards or policies. This shows the uniqueness of each university's curriculum model in terms of the standards or policies followed.

   A guiding principle for the reports is that they should be broadly based. Meaning that the development of the CC2001 and IT2005 reports included participation from people, organizations and other interested parties other than the developers of the reports. In some categories of the single case analysis, there is a mention that the curriculum development process or review process and even the implementation process involved several people. By this, they are basing their reports broadly and engaging in participatory development process. The category on curriculum development and review under background information highlights some of the participatory involvement in the development process.

   Another guiding principle of the reports was about keeping the body of knowledge of the degree programs as small as possible. This is because of the changes in the disciplines that introduces new areas in its body of knowledge. Therefore, review of the degree curricula models should be done regularly in order to streamline the degree programs. The curriculum development and review categories in the previous chapter shows the review process that have been undertaken by the respective institutions, the reasons for it and the factors that were taken into consideration during the review process.

The guiding principles of the reports also define a set of characteristics that the graduates from the degree programs in the discipline should have. Therefore, the degree curricula models in the respective institutions should also describe the characteristics that the graduates will possess once they complete the programs regardless of the individual standards followed. These are shown mainly through the objectives of the curriculum. Therefore. the curriculum objectives and curriculum specialization categories in the previous chapter shows the kind of graduates the curriculum models in the respective institutions would produce. Most of these institutions would produce graduates in software engineering and databases.

The IT2005 and CC2001 reports differentiate between the degree programs in their respective fields by describing in detailed length implementation strategies suitable for each program. Chapter three elaborates more on this aspect. The implementation strategies used in the respective institutions are shown in the curriculum organization category. Most of them use the traditional based method of strategy integrated with their own individual method of implementation.

3. **Structure of the body of knowledge**
   The structure of the body of knowledge from the reports in chapter three constitutes of that which are either core or elective courses. They differentiate between the two in that, the core courses are those that are compulsory for the graduates of the respective degree programs while the elective courses are those that are optionally chosen by the graduates in the program so as to learn in their areas of interest in the respective discipline. See Appendix A for structure of the body of knowledge for both CS and IT disciplines

   The structure of the body of knowledge of the degree programs in each institution under study is different. Apart from the disciplinary courses in the curriculum, there are also additional compulsory courses in it defined by the institution or the department. They are usually known as the university core or department core. The curriculum organization category shows the difference between the courses offered in the institutions in addition to the disciplinary courses.

The disciplinary courses are within the body of knowledge of the respective discipline around the area of specialization of the curricula models.

4. **Overview of the curricula models**
As already mentioned in chapter three, curricula models are divided into three levels: introductory, intermediate and advanced levels. Courses in the body of knowledge are grouped within these levels but they are independent of each other. Curricula models also contain implementation strategies of it. Both reports elaborates in detailed length about the possible strategies that can be used to implement the curricula models within their respective disciplines. From the previous chapter, the curriculum organization category describes the overview of the different curricula models in the institutions under study. This includes structure of the curricula models and the implementation strategies used. Among the various methods of implementation, there is an emphasis on the practical skills in all cases through practical lab sessions, industrial attachments and project work etc during the period of study.

5. **Completing the curriculum**
Completing the curriculum, in addition to the body of knowledge, structure of the model and the implementation strategies, constitutes the requirements needed by the graduates of the respective CS or IT disciplines, in order to complete the degree programs. These requirements include knowledge in mathematics, knowledge in scientific methods, application domains, communication skills and team work spirit. Chapter three elaborates in more detail about this feature.

The institutions under study address this characteristic feature in several ways. For instance, among the admission requirements (See Appendix D) for the prospective students, they seek for prior knowledge in mathematics and science from the past educational qualifications of the students in these areas. They have also included mathematics and scientific courses in their curricula models to ensure that these requirements are achieved. An example from the university cases, where mathematics and scientific courses have been included in the curriculum model is Kabarak University's CS curriculum model. The inclusion of these courses in the curricula models is one of the recommendations of the task force of the CC2001 and IT2005 reports.

Knowledge in the application domains is important. CC2001 and IT2005 reports task forces recommends that in order for the institutions to fulfill this requirement, they should integrate case studies from their society into their curricula models or provide internships where the students would learn from their work environments. The university cases have exercised these two recommendations in several ways. All of them provide industrial attachments for their students and they also integrate case studies from their society in their curricula models in different ways. An example is University of Pretoria, where they have ten application areas in their structure of the degree curriculum in IT in which the students could pursue their careers.

Communication skills and team work spirit requirements for the graduates of both disciplines are important. As explained in chapter three, it is important for the students to exercise these requirements early enough during their curriculum implementation as they would be required in most cases to work in groups in their work environment. Through the learning processes such as class discussions, project work, industrial attachments, lecture hours etc in the respective institutions in the curriculum organization category, the students are exercising their communication skills and team work spirit. They also conduct courses for communication skills early enough in the curriculum to help the students during their studies and beyond. The above methods are recommended by CC2001 and IT2005 as ways in which these requirements can be achieved.

6. **Professional practice**
CS and IT degree programs are professional programs. Therefore the institutions offering these programs have an obligation of training their students to be professionals. CC2001 and IT2005 reports emphasize of this feature. They recommend that different ways can be used to train the students on the professional practices but in which ever ways used more emphasis should be put through course exercises, projects and examinations. The university cases exercise this feature mostly through the industrial attachments for the students as they are required to spend most of the time during this period in their work environments. This is shown in the curriculum organization category in the previous chapter.

7. **Characteristics of the graduates**
   This feature regards to the output of the curricula models. The graduate of IT and CS programs can be differentiated by the set of characteristics they have. These characteristics are in line with the students' careers in their respective fields and they are mostly determined by the set of objectives to be achieve by the curricula models. Chapter six, in the curriculum objectives category shows the different objectives of the curricula models of the respective institutions. The curriculum specialization category also determines the characteristics of the students in the respective institutions. Most, if not all, of the university cases specialize in software engineering and databases and therefore the graduates of these programs are likely to be software developers, system analysts, database designers and analysts among others.

Summary

This section contains the summary of the above comparisons showing the extent in which the curricula models adhere to the international guidelines and recommendations in degree curriculum development in CC2001 and IT2005. Figure 7.2 this summary.

Characteristic features in ACM reports	Extent of the curricula models to the international standards
1. Changes in the discipline	-The changes lead to curriculum review process of the curricula models -The changes facilitated pedagogical methods of the curricula models -The changes provided effective means of communication during the implementation of the curricula models
2. Guiding principles	-There was participatory development process of the curricula models -The curriculum development or review process followed standards or policies. -They defined a set of characteristics of graduates of CS/IT
3. Structure of body of knowledge	-Each institution has structure of body of knowledge in CS/IT. -Difference brought about by the additional courses defined by the faculty or institution.
4. Overview of the curricula models	-Duration of the programs: 3 yrs or 4yrs -Levels of study 1st yr, 2nd yr, 3rd yr & 4th yr -Implementation strategies: learning process, assessment process and practical experience
5. Completing curriculum	-They sought prior knowledge in mathematics & sciences from admission requirements -They had integration of science and mathematics courses in the curriculum models. -They had interdisciplinary courses and case studies integrated in the curriculum. -Provision of industrial attachments and projects. -Practiced communication skills and working in groups in the learning process. -They had courses in communication skills.
6. Professional practices	-There was integration of professional practice courses in curriculum -Practiced professional practices during industrial attachments and projects development process.
7. Characteristics of graduates	-Graduates from computer science and information technology degree courses.

Figure 7.2: A summary of the extent in which the degree curricula models for CS and IT comply to the guidelines in CC2001 and IT2005.

7.2 Contextual sensitivity of curricula models

This section will analyze the roles of the degree curricula models of the university cases in the society in five perspective as defined by Webster. The role of CS and IT degree curricula models will be analyzed through its contribution to the overall roles of the universities to the society.

1. **Technological Approach**
   This approach indicates the coming of an *information society* by the indication of the rise of new technologies in the society. Chapter two gives more details on how Webster views this approach. The application of ICT facilities in the running of HEIs describes the institutions as technological centers. This is because HEIs contain the state-of-the art technologies available for the members of the society to use and with the ability to connect societies. Therefore, the role of HEIs in this approach is the provision of the much needed technologies in the society to be used for various purposes such as communication, teaching, learning and for research activities. The benefits of ICT facilities in the running of the institutions are discussed in chapter two.

   CS and IT degree programs are technologically supported programs. Therefore, HEIs offering these degree programs must have the facilities or technologies available to support them. The university cases, from the case study database, have the necessary technology facilities to run the degree programs in their institutions. However, one challenge or problem they face during the development and implementation of their degree curricula is the limited technological facilities available to support the growing number of the students joining the respective degree programs.

   These technological facilities include personal computers, computer laboratories, network cables, internet, printers, telephones etc. They facilitate forums for communications, collaborations, distance learning. e-learning, self-study as the educational materials are readily available for the students electronically among others.

2. **Economical Approach**
   This approach centers on the information activities in the society and their value to the economy of the country. Webster elaborates in more detail concerning this approach in chapter two. Figure 2.1 of Allen and Thomas's definition of the scope of ICT in the society contains factors that influence the use of

ICT. These factors are also information activities and they include banking, health-care, marketing, transport and communications, governance, politics among others. They influence the use of ICT in the processing of the information and the outcome contributes to the growth of the economy in the country.

Therefore, HEIs in this approach have a role to strengthen the domestic institutions in the different information activities areas by conducting research activities. These research activities can be focused on new ways of improving the information activities practices by the integration of ICT facilities in it and this yields productive outcomes. HEIs also strengthen the domestic institutions by producing knowledgeable and skilled human resource capital for the various information sectors.

The roles of the CS and IT degree curricula model in the university cases are discussed in the curriculum benefits, curriculum specialization and uniqueness, curriculum objectives and curriculum organization categorizes in the previous chapter. These roles include conducting research activities in this fields to support the domestic institutions, producing graduates with knowledge and skills in either CS or IT fields, identification and analysis of problems in the society and provision of technological solutions to these problems. They also facilitate for collaborations with the IT industries in various developmental projects and also provide for industrial attachments within the society.

3. **Occupational Approach**
This approach defines an *information society* when people use technologies to manipulate information activities in their work environments. Chapter two elaborates more on how webster defines an *information society* from this approach. The main role of HEIs in this perspective is through production of graduates from different areas of specialization to add up to the country's human capital development. These graduates will then take up job opportunities in different information activities areas in the society. The university cases through their CS and IT degree curricula models contribute to this role by producing graduates in this areas. The curriculum objectives category shows the characteristics that the graduates in CS or IT degree programs possesses. The degree curricula models, in the curriculum organization category, also provide for industrial attachments for its students within the society and thus providing for human resources in the IT industries. Therefore, in this context, HEIs are knowledge centers where African expertise in CS and IT are being developed. They are also knowledge centers where members of the society are trained to be professionals in either CS or IT.

4. **Spatial Approach**
   In this approach, information networks indicate an *information society*. HEIs are therefore information network centers as they have the infrastructure to connect the society to other societies nationally, regionally and even globally. Within the information networks, various information activities are carried out such as exchange of information, communications and collaborations between societies. Chapter two elaborates in more detail about what is contained in the information networks. From the university cases under study, the role of CS and IT degree curricula models in this approach is to facilitate for collaborations between universities within and outside the region and also for collaborations with the IT industries in the society. These collaborations are through conducting various projects together that will benefit both the institutions and the industries. Through these collaborations, the institutions are also able to share their resources and hence promote capacity building within the HEIs in the region. They also facilitate online courses such as distance learning and e-learning and hence they support the students learning process. The categories that contains information on these roles are curriculum objectives, curriculum benefits and curriculum recommendations.

5. **Cultural Approach**
   This approach defines an *information society* by the availability of information in the society. A society that contains members with different cultural and social backgrounds. HEIs are representatives or units of the society as they also contain people with different and various cultural backgrounds working together. HEIs are also information centers in this approach as the main element of the various activities conducted in the institutions deals with manipulation of information to gain new knowledge. Webster describes more about this approach in chapter two. The roles of CS and IT degree curricula models of the university cases include training of the members of the society in the areas of CS and IT disciplines, analyzing of technology problem cases in the society and finding technological solutions for them, providing human resources to information industries in the society in IT sectors and conducting projects in the society that brings about development. The members of the society are trained to be professional people in IT and CS and hence they improve their own standards of living and also participate in the nation building of their countries. The categories that contains information on these roles include curriculum objectives, curriculum benefits and curriculum recommendations.

Summary

The contextual sensitivity of the curricula models of the university cases in the above perspectives are summarized in Figure 7.3.

Perspectives	Curricula models' contextual sensitivity
1. Technological	-They providing technological solutions to problems in the society. -They provide training on the existing and new technologies and knowledge on application domains.
2. Economical	-They identify problems in the society -They provide collaborations with the local IT industries in various development projects. -They integrate case studies in curriculum -They provide industrial attachments and research projects for development.
3. Occupational	-They produce graduates with knowledge and skills in computer science and information technology. -They provide industrial attachments in local IT industries.
4. Spatial	-They facilitate collaborations between universities -They facilitate collaborations with IT industries -They provide distance learning and E-learning opportunities.
5. Cultural	-They integrate of case studies from the society in the curriculum -They produce knowledgeable and skilled human resource capital for the society. -They provide technological solutions to problems in the society. -They improve the standards of living of the members of the society.

Figure 7.3: A summary of the extent in which the degree curricula models for CS and IT address the needs of the society.

Chapter 8

Conclusion and Recommendations

There is no "one-fit-all" curricula model for the degree programs such as CS and IT that can be implemented in all institutions around the globe. Each of the institutions in the study have their own unique curriculum they implement. The idea of specific standards for discipline during the development of the degree curriculum is for identification of the discipline itself regardless of where it is being offered through its curriculum and hence internationally recognized. The graduates of these programs will also be internationally recognized as they will possess the required characteristics of the graduates of the discipline and therefore they could pursue further their careers in different geographical locations in different areas.

Much of the degree curriculum development process in the case universities has been focused on training of the graduates with knowledge and skills required to join the job market. It is during the review process that the discipline's standards in curriculum development are being taken into consideration. Most of the university cases are reviewing their curricula models in accordance to CC2001. The study has shown that even though the universities followed their own guidelines of developing or reviewing their degree curricula models in CS and IT, the issues they took into consideration are in accordance to the CC2001 and IT2005 reports. Therefore, they comply with the disciplines standards as this brings "uniformity" in the implementation of the degree curricula models for CS and IT. The study has also shown that the curricula models have been focused on the needs of the society ever since the degree programs were first implemented. The focus is through the implementation strategies used, benefits and objectives of the curricula models and hence, it reflects how these curricula models are sensitive to the needs of the societies around them.

Therefore, both disciplinary standards and contextual needs of the societies, are equally important aspects in the development and the implementation of the universities' degree curricula in CS and IT. The balance between the two aspects can thereby be achieved by utilizing the standards in the curricula as it is, and on the other hand, customizing the models towards addressing the needs of the local societies.

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Appendix A

Table 1: Computer Science Body of knowledge with core topics underlined

DS. Discrete Structures (43 core hours)	**HC. Human-Computer Interaction (8 core hours)**
DS1. Functions, relations, and sets (6)	HC1. Foundations of human-computer interaction (6)
DS2. Basic logic (10)	HC2. Building a simple graphical user interface (2)
DS3. Proof techniques (12)	HC3. Human-centered software evaluation
DS4. Basics of counting (5)	HC4. Human-centered software development
DS5. Graphs and trees (4)	HC5. Graphical user-interface design
DS6. Discrete probability (6)	HC6. Graphical user-interface programming
PF. **Programming Fundamentals (38 core hours)**	HC7. HCI aspects of multimedia systems
PF1. Fundamental programming constructs (9)	HC8. HCI aspects of collaboration and communication
PF2. Algorithms and problem-solving (6)	**GV. Graphics and Visual Computing (3 core hours)**
PF3. Fundamental data structures (14)	GV1. Fundamental techniques in graphics (2)
PF4. Recursion (5)	GV2. Graphic systems (1)
PF5. Event-driven programming (4)	GV3. Graphic communication
AL. Algorithms and Complexity (31 core hours)	GV4. Geometric modeling
AL1. Basic algorithmic analysis (4)	GV5. Basic rendering
AL2. Algorithmic strategies (6)	GV6. Advanced rendering
AL3. Fundamental computing algorithms (12)	GV7. Advanced techniques
AL4. Distributed algorithms (3)	GV8. Computer animation
AL5. Basic computability (6)	GV9. Visualization
AL6. The complexity classes P and NP	GV10. Virtual reality
AL7. Automata theory	GV11. Computer vision
AL8. Advanced algorithmic analysis	**IS. Intelligent Systems (10 core hours)**
AL9. Cryptographic algorithms	IS1. Fundamental issues in intelligent systems (1)
AL10. Geometric algorithms	IS2. Search and constraint satisfaction (5)
AL11. Parallel algorithms	IS3. Knowledge representation and reasoning (4)
AR. Architecture and Organization (36 core hours)	IS4. Advanced search
AR1. Digital logic and digital systems (6)	IS5. Advanced knowledge representation and reasoning
AR2. Machine level representation of data (3)	IS6. Agents
AR3. Assembly level machine organization (9)	IS7. Natural language processing
AR4. Memory system organization and	IS8. Machine learning and neural networks

architecture (5)	
AR5. Interfacing and communication (3)	IS9. AI planning systems
AR6. Functional organization (7)	IS10. Robotics
AR7. Multiprocessing and alternative architectures (3)	**IM. Information Management (10 core hours)**
AR8. Performance enhancements	IM1. Information models and systems (3)
AR9. Architecture for networks and distributed systems	IM2. Database systems (3)
OS. Operating Systems (18 core hours)	IM3. Data modeling (4)
OS1. Overview of operating systems (2)	IM4. Relational databases
OS2. Operating system principles (2)	IM5. Database query languages
OS3. Concurrency (6)	IM6. Relational database design
OS4. Scheduling and dispatch (3)	IM7. Transaction processing
OS5. Memory management (5)	IM8. Distributed databases
OS6. Device management	IM9. Physical database design
OS7. Security and protection	IM10. Data mining
OS8. File systems	IM11. Information storage and retrieval
OS9. Real-time and embedded systems	IM12. Hypertext and hypermedia
OS10. Fault tolerance	IM13. Multimedia information and systems
OS11. System performance evaluation	IM14. Digital libraries
OS12. Scripting	**SP. Social and Professional Issues (16 core hours)**
NC. Net-Centric Computing (15 core hours)	SP1. History of computing (1)
NC1. Introduction to net-centric computing (2)	SP2. Social context of computing (3)
NC2. Communication and networking (7)	SP3. Methods and tools of analysis (2)
NC3. Network security (3)	SP4. Professional and ethical responsibilities (3)
NC4. The web as an example of client-server computing (3)	SP5. Risks and liabilities of computer-based systems (2)
NC5. Building web applications	SP6. Intellectual property (3)
NC6. Network management	SP7. Privacy and civil liberties (2)
NC7. Compression and decompression	SP8. Computer crime
NC8. Multimedia data technologies	SP9. Economic issues in computing
NC9. Wireless and mobile computing	**SE. Software Engineering (31 core hours)**
PL. Programming Languages (21 core hours)	SE1. Software design (8)
PL1. Overview of programming languages (2)	SE2. Using APIs (5)
PL2. Virtual machines (1)	SE3. Software tools and environments (3)
PL3. Introduction to language translation (2)	SE4. Software processes (2)
PL4. Declarations and types (3)	SE5. Software requirements and specifications (4)
PL5. Abstraction mechanisms (3)	SE6. Software validation (3)

PL6. Object-oriented programming (10)	SE7. Software evolution (3)
PL7. Functional programming	SE8. Software project management (3)
PL8. Language translation systems	SE9. Component-based computing
PL9. Type systems	SE10. Formal methods
PL10. Programming language semantics	SE11. Software reliability
PL11. Programming language design	SE12. Specialized systems development
	CN. Computational Science (no core hours)
Note: The numbers in parentheses represent the minimum number of hours required to cover this material in a lecture format. It is always appropriate to include more.	CN1. Numerical analysis
	CN2. Operations research
	CN3. Modeling and simulation
	CN4. High-performance computing

Table 2: Information Technology Body of knowledge with core topics underlined

ITF. Information Technology Fundamentals (33 core hours)	**PT. Platform Technologies (14 core hours)**
ITF1. Pervasive Themes in IT (17)	PT1. Operating Systems (10)
ITF2. Organizational Issues (6)	PT2. Architecture and Organization (3)
ITF3. History of IT (3)	PT3. Computing infrastructures (1)
ITF4. IT and Its Related and Informing Disciplines (3)	PT4. Enterprise Deployment Software
ITF5. Application Domains (2)	PT5. Firmware
ITF6. Applications of Math and Statistics to IT (2)	PT6. Hardware
HCI. Human Computer Interaction (20 core hours)	**SA. System Administration and Maintenance (11 core hours)**
HCI1. Human Factors (6)	SA1. Operating Systems (4)
HCI2. HCI Aspects of Application Domains (3)	SA2. Applications (3)
HCI3. Human-Centered Evaluation (3)	SA3. Administrative Activities (2)
HCI4. Developing Effective Interfaces (3)	SA4. Administrative Domains (2)
HCI5. Accessibility (2)	**SIA. System Integration and Architecture (21 core hours)**
HCI6. Emerging Technologies (2)	SIA1. Requirements (6)
HCI7. Human-Centered Software Development (1)	SIA2. Acquisition/Sourcing (4)
IAS. Information Assurance and Security (23 core hours)	SIA3. Integration (3)
IAS1. Fundamental Aspects (3)	SIA4. Project Management (3)
IAS2. Security Mechanisms (Countermeasures) (5)	SIA5. Testing and QA (3)
IAS3. Operational Issues (3)	SIA6. Organizational Context (1)
IAS4. Policy (3)	SIA7. Architecture (1)
IAS5. Attacks (2)	**SP. Social and Professional Issues (23 core hours)**
IAS6. Security Domains (2)	SP1. Professional Communications (5)
IAS7. Forensics (1)	SP2. History of Computing (3)
IAS8. Information States (1)	SP3. Social Context of Computing (3)
IAS9. Security Services (1)	SP4. Teamwork Concepts and Issues (3)
IAS10. Threat Analysis Model (1)	SP5. Intellectual Properties (2)
IAS11. Vulnerabilities (1)	SP6. Legal Issues in Computing (2)

IM. Information Management (34 core hours)	SP7. Organizational Context (2)
IM1. IM Concepts and Fundamentals (8)	SP8. Professional and Ethical Issues and Responsibilities (2)
IM2. Database Query Languages (9)	SP9. Privacy and Civil Liberties (1)
IM3. Data Organization Architecture (7)	**WS. Web Systems and Technologies (21 core hours)**
IM4. Data Modeling (6)	WS1. Web Technologies (10)
IM5. Managing the Database Environment (3)	WS2. Information Architecture (4)
IM6. Special-Purpose Databases (1)	WS3. Digital Media (3)
IPT. Integrative Programming & Technologies (23 core hours)	WS4. Web Development (3)
IPT1. Intersystems Communications (5)	WS5. Vulnerabilities (1)
IPT2. Data Mapping and Exchange (4)	WS6. Social Software
IPT3. Integrative Coding (4)	
IPT4. Scripting Techniques (4)	
IPT5. Software Security Practices (4)	**Total Hours: 281** **Notes:** 1. Order of Knowledge Areas: Fundamentals first, then ordered alphabetically. 2. Order of Units under each Knowledge Area: Fundamentals first (if present), then ordered by number of core hours.
IPT6. Miscellaneous Issues (1)	
IPT7. Overview of programming languages (1)	
NET. Networking (20 core hours)	
NET1. Foundations of Networking (3).	
NET2. Routing and Switching (8)	
NET3. Physical Layer (6)	
NET4. Security (2)	
NET5. Application Areas (1)	
NET6. Network Management	
PF. Programming Fundamentals (38 core hours)	
PF1. Fundamental Data Structures (10)	
PF2. Fundamental Programming Constructs (9)	
PF3. Object-Oriented Programming (9)	
PF4. Algorithms and Problem-Solving (6)	
PF5. Event-Driven Programming (3)	
PF6. Recursion (1)	

Appendix B

Telephone Interview Questions

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Thesis Topic

Standards and Contextual Sensitivity: A comparative study of five CS/IT degree curricula implemented in SSA countries.

Thesis Statement

The study aims to investigate the extent in which the computer science or Information Technology degree curriculum model implemented in respective universities under-study comply with the guidelines and recommendations in the standard curriculum model CC2001 or IT2005 and also the extent in which these curriculum models address the needs of the local society around the institutions.

Research Questions

1. What guidelines and recommendations or standards or model does the computer science curriculum implemented in respective universities follow?

2. How has the implementation of the computer science curriculum in respective universities addressed the local society needs around the institutions?

Interview questions

With regards to the first research question:

Curriculum

1. If you are familiar with the development process of your institution's computer science or Information Technology curriculum, briefly describe it. What guided the development of it? (Institution/national/international standards) (What do you think about CC2001 if you are familiar with it?)

2. What are the main objectives and goals of your curriculum?

3. What are the challenges and problems you faced during the development and implementation of your curriculum?

4. Briefly describe the organization of your curriculum and comment on it. What teaching methodology do you employ for your curriculum?

5. Computer Science is a large field of study, in what areas is your curriculum specialized in?

6. Would you recommend your curriculum to be reviewed? (If yes) What are your reasons for reviewing it?

With regards to the second research question:

Curriculum and local needs

1. Each curriculum in each institution is quite different, what is unique about your institution's curriculum?

2. During the development of the curriculum, what factors were taken into consideration to benefit the institution and the students following the curriculum?

3. Briefly discuss some of the local needs in your society that is related to ICT. What are some of these local society needs taken into consideration during the development of your curriculum?

4. Could you give some examples of courses in your curriculum that address these needs and comment on how they address them? How would you describe the benefits of your curriculum in general?

5. What would you recommend, in addition to your curriculum, to further benefit your institution and society as a whole?

6. In your own opinion, what are your views in general about curriculum development for undergraduate studies in the field of computer science?

7. How do you see the balance between the local society needs and the international standard models such as CC2001?

8. Anything else you would like to add about your curriculum?

Appendix C

Case in Makerere University

Categories	Data collected
Curriculum Development and review	The faculty of computing and information technology houses degree programs computer science and Information Technology. Computer science degree programs started in 2001 while the information technology degree programs started the next year 2002. The developers of the first curriculum were people with some kind of qualifications in the discipline of computing and mathematics and admission to the programs were open. The review of the curriculum was first done for Computer Science program by 2006 and it was revised in accordance to CC2001 guidelines. The review for Information Technology program is still under process and it is also in accordance to CC2001 guidelines. **Reasons for reviewing** To streamline the discipline to have focus hence deliver quality. To train the students to have the right skills and knowledge. To accommodate for research orientation. To revise the initial admission requirements. To enable the graduates to be accepted widely in other institutions and industries within the field of computer science. **Curriculum review factors taken into consideration** The industry expectations through collaboration with the IT industry Pure academic discipline Collaboration with other universities
Standards and policies	University procedures and guidelines on the programs offered.
Curriculum objectives	These objectives are for both computer science and Information Technology degree programs. To produce professionals with adequate theoretical and practical knowledge and skills in computer science. To produce adequate human resources within the country with computer science skills to influence ICT related activities within the country. To be a research oriented institution and hence participating with other

	institutions and industries internationally. To produce graduates who are able to apply their ICT skills and knowledge in real life situations. To train graduates for other universities within the country to promote the discipline of computer science and information Technology.
Curriculum Challenges and problems	**Development Challenges** During development of the curriculum there was lack of human resources with the required knowledge in developing and implementing the curriculum. The program approval organs of the institution are not so much conversant with the discipline of computer science. It was not based on international standards but on people's qualification with some knowledge in computing. **Implementation Challenges** The review of the curriculum could only be done after four years because university policy stated so. The growing number of students participating in both degree programs was not proportional to the resources available in the universities. The number of staff available was small at the beginning but now growing fast. There are some students who do not finish within the three year period of the degree programs.
Curriculum organization	**Program duration** Lasts for 3 academic years **Learning experience** (15crswk +2examwk=17 semesters) lecture/contact hours, tutorial hours and practical hours. **Examination process** (Assessment tests after every sixth week period and then exams after the 15th week. Assignments are given by lecturers) **Practical experience** After 1st year=10 weeks of practical skills After 2nd year=10 weeks of industrial training After 3rd year=industrial projects work
Curriculum specialization and uniqueness	**Specialization** Databases Networking and telecommunication Software Engineering

	Uniqueness It has an industrial focus. It is open to International Collaboration (Partnership with IBM, Google, Cisco systems) – Thus, providing extra avenues for the students to sharpen their knowledge and skills in both computer science and information technology.
ICT related societal needs	The need for ICT for facilitating government programs in Uganda Exploitation of ICT opportunities in Uganda and the neighboring countries
Recommendations	Establish partnership with the industries to inform on what is lacking in the curriculum. Standardization of the programs. Establish research programs that will bring in money to the university. Should look at CC2001 model hence uniformity. There should be clear cut definition between CS and mathematics.
Curriculum benefits	Field attachment programs bring about the interaction between the students and the job industries. Entrepreneurship programs for both IT&CS Soft skill programs-communication skills, literacy, languages hence making the curriculum to be responsive to the local environment.
Balance between standards and societal needs.	The balance is up to the departments to strike. We have an obligation to customize the standard model to the local society needs. The customizations should be done in view of the standard model so that the deviation is in the local needs but the background of the discipline should remain the same.

Case in University of Namibia

Categories	Data collected
Curriculum Development and Review	The curriculum was developed so as to provide for the need for capacity building in terms of human resources in the field of computer science. This is because the country earlier sent people to universities abroad to be trained so as to produce human resources. The curriculum has been reviewed and implementation of it started in 18th February 2008. **Reasons for reviewing** To determine the departments level and how the curriculum fits with international standards. **Curriculum review factors taken into consideration** Financial and human resource implications. Timetable and venue implications. Year book implications. Implications for students promotions. Other bodies within and stakeholders outside UNAM. Program design.
Standards and policies	The curriculum follows the models, guidelines or standards provided by the Namibian Qualification Authority (NQA) which is heavily influenced by the South African Qualifications Authority (SAQA). It is also based on the specifics in the technology or basic development policy in Namibia which is guided by the vision 2030 whereby Namibia aspires to be a fully industrialized and an information society by year 2030.
Curriculum objectives	To enable students who would like a single major in Computer Science and hence contributing to the national effort towards self sufficiency in human resources in the field of computing.
Challenges and problems	**Development** The basic challenge was that the guidelines provided did not have enough in the way of the content of the modules that have to be included in the curriculum. Financial and resource problems: compromise between timetabling of the courses and the laboratories and lecture rooms capacity. **Implementation** Curriculum timetabling and synchronizing it with other departments timetables that offer course from computer science department. Lack of enough resources and facilities.

Curriculum organization	The department offers both major and a minor degree. A major in computer science and a minor in either mathematics or statistics and information technology. **Program duration** Lasts for 4 academic years. **Learning experience** It is through lectures and lab practical sessions or lectures and tutorials for those modules that don't involve lab work. **Assessment process** Depends on whether the module is half or full. Full module assessment: Continuous assessment: 50% Min No. of tests: 2 Min No. of Assignments: 2 1*3 hrs of final exams 50% Half module assessment: Continuous assessment: 50% Min No. of tests: 2 Min No. of Assignments: 2 1*2 hrs of final exams 50% **Practical experience** Through laboratory work, field attachment in an industry and a research project that involves design, development and implementation of software.
Curriculum specialization and uniqueness	Tendency towards software engineering and databases. No particular uniqueness as it only tries to rhyme with other universities' curricula so that the students would get entry for graduate and post graduate studies.
ICT related societal needs	The need to develop and deploy application software for various problem situations. The need to improve the management of IT systems. The need to properly manage software engineering problems.
Recommendations	More involvement of the University of Namibia in information related activities to reach people that are rural based.
Curriculum benefits	The benefits of the curriculum are derived from integrating theory and practice so that the modules in the curriculum provides the concepts, skills, tools, and techniques required for addressing the needs of the society.
Balance between standards and societal needs.	The current curriculum needs a lot of modification to reach the standards that have been suggested in the CC2001 guidelines. The level entry to university education in Namibia is a bit low to pitch up the

	curriculum to the level of CC2001 and in order to overcome this the university is introducing preliminary courses that will prepare the students to the entry level into the field of computer science as in accordance to CC2001 guidelines.

Case in Tumaini University

Categories	Data collected
Curriculum development and review	The development of the curriculum is still under process. The degree program was first offered in September 2007 and before that, only courses in computing were offered in different departments. The development process started from the grass-root level through ideas and indications from short courses offered in the University and projects conducted within the region. There were also ideas from stakeholders (Finnish missionaries, lecturers, International researchers, computer education research community) who were involved in the process. There were also Tanzanian authorities involved in the process such as Ministry of Higher Education, Ministry of Education and Vocational training, Tanzanian commission of University, Tanzanian Education Authority and Tanzanian Board of Education. **Review** Since the curriculum is still at its initial implementation stages, a review of it has not been yet been done. **Curriculum development factors taken into consideration** Basically the local needs of the Tanzanian region, the IT industry, ICT oriented organizations etc.
Standards and policies	The Curriculum was based on the CATI model. It follows six principles: - contextualized programme, problem-based projects, practically oriented, internationally recognized, research based and Interdisciplinary. The policies, regulations and standards of the university and the educational sector in Tanzania.
Curriculum Objectives	To enable students to identify early enough the societal expectations from technology. To train students to take up any IT related jobs in the country. To enable the students to continue with graduate education in computing. To ensure the program contributes positively to the local community
Challenges and problems	**Development** The most important one was to build a rapport, trust and understanding with the

	university that was to implement the curriculum since the researchers were not from within. There were also financial issues during the development process. The belief that the research was going to be one of the many researches that just end up in the library. The idea that the resultant curriculum should be a universal curriculum i.e. accepted internationally was also important. **Implementation** *Pedagogy*: -How to encourage independent studying/work. -How to address ideas about automatic computation into a form that is meaningful for the students. *Curriculum Design:* -Almost every topic is new & the students have little existing knowledge about the things we deal with i.e. it is very difficult to establish a meaningful and logical order for course work. *Community outreach:* -There are no established connections with the local community. Need to be very open to new ideas about university community interaction.
Curriculum organization	**Program duration:** Lasts for 3 academic years **Learning experience** lecture hours, practical hours, on-line distance learning, assignments, discussions and group works. **Assessment process** Tests 25% Practical Assignments 25% Examinations 50% **Practical experience** Practical sessions Industrial attachments
Curriculum specialization and uniqueness	**Specialization** Professionalism **Uniqueness** The practicality nature of the curriculum. The focus being on the needs of the local society.
ICT related societal	As the curriculum is still young and one of the objectives being early

needs	identification by the students of the societal needs that can be addressed by technology, the students are currently conducting a fieldwork study to identify these needs in the society.
Recommendations	A heavier emphasis on e-learning should be put. It can have very positive and productive outcomes for very small investments. Encourage ICT4D and also interdisciplinary.
Curriculum benefits	It's neither too theoretical oriented nor practically oriented. The adoption of problem-solving approach seems to be working well; both the students and teachers like it. It seems to encourage the students to take initiative in problem solving situations.
Balance between standards and societal needs	It is kind of dynamic. It is important to have the local stakeholders in the Iringa region to first of all identify their needs both explicitly and implicitly through conducting studies and projects in the region and that they should also materialized and understand the international standards in the field of computing as something that can have impact in the local society.

Case in Kabarak University

Categories	Data collected
Curriculum development and review	The curriculum was found already in-place by the members of the department. The developers were members of other universities within the country who collaborated together to construct a curriculum by making a comparison of their own curricula and forming a hybrid curriculum. The curriculum review is still under process. **Reasons** The field is dynamic, review to accommodate change. They were not the developers thus they would like to create something of their own . **Curriculum development factors taken into consideration** To make use of the available facilities in the institution and provide the necessary knowledge and skills to the market..
Standards and policies	Since the developers are not known by the people implementing the curriculum, the standards or policies followed during the development process are not known for sure.
Curriculum Objectives	Train highly motivated world-class programmers, computer Scientists and software engineers. Provide IT professionals to staff in local IT-oriented organizations. Provide IT professionals with an entrepreneurial outlook and the capacity to create viable business ventures that embrace computing as a tool. Create a pool of IT professionals capable of defiling the future direction of this country's IT industry. Provide the graduate with high-technology skills to improve their employability and potential for economic impact. Create young professionals with a commitment to excellence, high productivity, and social responsibility. Provide basic training for those wishing to take up postgraduate programmes in Information Technology Create a center of excellence in Information Technology at Kabarak University.
Challenges and problems	**Implementation** The developers of the curriculum are not members of the departments' current staff and therefore the implementation challenge being faced is trying to interpret what the objectives of the developers were for some courses.

	Some of the courses are increasingly becoming more and more outdated hence the need for regular reviewing. The process of reviewing the curriculum is however quite slow because of shortage of full-time (regular) staff in the department. The staff present are also heavily loaded with teaching duties. The university also operates a trimester (three semester) calendar year and therefore the staff do not have time to relax hence the fatigue can affect quality delivery of the curriculum.
Curriculum organization	**Program duration:** Lasts for 4 academic years **Learning experience:** Lecture hours, course work presentations, assignments, tutorials, lab sessions, examinations. **Assessment process:** Continuous Assessment Test 50% Examinations Pass mark is 60% Industrial attachments assessed by supervisor report and field team assessment. **Practical experience:** Through lab practical sessions and also industrial attachments. Industrial attachment takes 16 weeks with supervision by field supervisor.
Curriculum specialization and uniqueness	**Specialization:** Software engineering **Uniqueness:** The additional courses offered that are in line with the vision and mission of the institution. There are good infrastructure and computer facilities.
ICT related societal needs	Communication systems Farming, marketing of products Transport system
Recommendations	Collaborations between universities and companies Curriculum review should be done regularly and it should be done in collaborations with the IT industry. Entrepreneurship courses should be included into the curriculum.
Curriculum benefits	The curriculum covers a wide range of topics in computer science thereby creating a solid grounding for students in all areas especially in the early stages. In the latter stages, students are given a chance to specialize in areas they feel more comfortable in. This creates more motivation on the side of the student as they enjoy what they are studying.

	The provision of industrial attachment is also an advantage as it gives practical skills to students and enhances their learning experience. Provision of non-computer courses (common core courses) such as communication & study skills, bible courses etc.
Balance between standards and societal needs	_

Case in University of Pretoria

Categories	Data collected
Curriculum development and review	The school of Information Technology houses the department of Computer Science which offers undergraduate degree programs in both computer science and information technology. The degree curriculum for computer science was reviewed for 2001/2002 and is about to go under another review process to be implemented in year 2009. The degree curriculum for information technology was reviewed in 2005 and implementation started in 2006. Before review of the degree curriculum of information technology, the graduates of this program could specialize in three areas: Computer Science; Computer Systems and Information and Knowledge management. During the review process of the curriculum, the area in Information and knowledge management was kept. **Reasons** **Factors taken into consideration** Industry and the institution: So that students can either join the job industry or pursue further education.
Standards and policies	The national standards guided the review process of the computer science degree curriculum for 2001/2002. In the second review that is soon to be carried out, the process will take into consideration CC2001 guidelines and the accreditation requirements. The degree program in information technology is also in-line with the national standards: South Africa Qualification Authority.
Curriculum Objectives	The main objective of the department is to explore and research the scientific basis of new technologies and promote the proliferation of reliable, robust and innovative computing and information technologies into the IT industry in South Africa. Earlier objective of computer science degree curriculum was to produce graduates with relevant knowledge for the IT industry in the world but nowadays the objective more towards the fundamental issues in computer science for accreditation purposes. The objective of the information technology degree program focuses on the industry related trends, providing wider background, additional niche and better job opportunities.
Challenges and problems	**Development and Implementation** Working within the parameters of the accreditation requirements as the goal of the curricula is striving for international accreditation.
Curriculum organization	**Program duration:** 3 Year program The modules in the curriculum are divided into fundamental, core and elective modules. The fundamental courses are specified by the University or faculty or department. The core modules comprises of the disciplines core courses and the

	electives are the disciplines optionally selected courses which distinguishes the students by the degree programs they are taking. The reviewed information technology degree curriculum provides ten information technology application environments in which the students could pursue a career, hence emphasizes multi-disciplinary application domain. These ten environments include: applied mathematics; bio-informatics;geographical information sciences;IT and enterprises; IT and law; IT and music; operational research; philosophy; and psychology. **Learning experience:** Assignments, Examinations, class discussions and tests, practicals. **Assessment process:** Examinations, tests, assignments **Practical experience:** practical sessions
Curriculum specialization and uniqueness	**Specialization:** The department has four research groups and therefore the curriculum is oriented towards these areas: Computational Intelligence Distributed systems Security Software engineering and finite Automata **Uniqueness:** The uniqueness is brought about from the objectives and focus area of the degree curriculum models: while the degree program in information technology focuses on application of computer science, the degree program in computer science focuses on the formal aspects of computer science. Bsc(IT) is unique as it focuses the studies in particular application domains. Bsc(CS) is unique as it is possible to do double major in Computer Science
ICT related societal needs	ICT needs in South Africa. Bsc(IT) took into consideration the ICT needs in South Africa and beyond during its development while Bsc(CS) focuses more on academic requirements.
Recommendations	Ethical values to be instilled to the graduate of the degree programs so that they can be ethical members of the society in their professions. Curriculum development in computer science in the past has been focused on courses that are relevant to the IT industries and the preparation of the graduates in the various IT areas to join the job market and hence, it lost its fundamental focus. Nowadays, there is change as focus in curriculum development in computer science is on its fundamental knowledge and the application of this knowledge to where it is relevant.
Curriculum benefits	The benefits are derived from the purposes of the modules in the degree curricula models.
Balance between standards and societal needs	With the aspects of globalization and IT, international standards would be required a basis for measurement. However, it is through individual approaches that there is innovation and therefore, with international standards, innovative approaches might be

	minimized.

Appendix D

University Cases Admission requirements

Universities	Admission requirements
Kabarak University	**BSc. Computer Science:** -Mean grade of C+ in KCSE with C+ in Mathematics and C (plain) in Physics. OR -2 principal passes at Advanced level, one of which must be in Mathematics, and a credit in Physics at Ordinary level, OR -Five passes of B and above in IGCSE (Ordinary level), two of which must be in Mathematics and Physics OR -A Credit Pass at Diploma level in the related areas of study from a recognized institution, OR -Pre-university certificate with credit pass or a GPA of 3.0
Tumaini University	**BSc. Information Technology:** **Category A: Direct Entry (Form Six Graduates)** Applicants eligible for direct admission to the degree programme must have earned: -A Certificate of Secondary Education Examination (CSEE) with credit level passes in three approved subjects (Mathematics inclusive), obtained prior to sitting for the Advanced Certificate of Secondary Education Examination (ACSEE) AND -An Advanced Certificate of Secondary Education Examination (ACSEE) with at least two principal passes one of which must be in Mathematics and a total of 4.5 or more points. **Category B: Equivalent Qualifications (Diploma holders)** Applicants eligible for equivalent admission to a degree programme must have either: -Must posses a diploma in information technology with an average grade of not less than "B" or a diploma in a related field from a recognized (accredited) institution -Met entry requirements at an accredited University in the applicant's home country (for foreign applicants) subject to approval by the IUCO Academic Board and the Tumaini University Senate. **Category C: Entrance Examination Qualifications** Applicants who have at least two principal passes, but have less than 4.5 total points on the ACSEE must pass the Tumaini University, Iringa University College Entrance Examination which consists of Mathematics and Physics. **Category D: Mature Age Entry** Applicants eligible for mature age admission to a degree programme must: -Be 25 years of age or older in the year of application -Have completed Form IV (or equivalent) at least five years prior to the year of application

	-Have attended extra-mural classes or residential courses and submit a letter of recommendation from the tutor, or Have attended a residential course at an Adult Education College and submit a letter of recommendation from the Principal; -Pass the Tumaini University, Iringa University College Entrance Examination which consists of Mathematics and Physics
Makerere University	**BSc. Computer Science:** **a. Direct Entry** -Candidates MUST have done Mathematics and At least have a subsidiary pass in the Uganda Advanced Certificate of Education (UACE) or its equivalent. -At least two principal passes at the same sitting in Uganda Advanced Certificate of Education (UACE) in any of the following subjects: -Mathematics, Economics, Geography, Physics, Chemistry, Biology, Agriculture, Technical Drawing and Food and Nutrition. -A minimum weighted points set by the Admissions Board. **b. Mature Age Entry Scheme** -For admission under the Mature Age Entry Scheme, a candidate must have passed the Makerere University Mature Age Entry Examinations. **c. Diploma Holders** -Applicants should possess at least a second class (lower division) diploma in Computer Science, Engineering, Business Studies, Information Technology, Statistics or any other diploma with either Mathematics or Computer Science, or Information Technology as one of the subjects from any recognized Institution. Applicants who possess an equivalent of a diploma in computer science such as the Cisco Certified Network Associate (CCNA) Certification also qualify under the diploma scheme. **BSc. Information technology:** **a. Direct Entry** Candidates seeking admission through this avenue must have obtained: - -The Uganda Certificate of Education (UCE) or its equivalent. -At least two principal passes at the same sitting in Uganda Advanced Certificate of Education (UACE) in any two subjects. **b. Mature Age Entry Scheme** For admission under the Mature Age Entry Scheme, a candidate must have passed the Makerere University Mature Age Entry Examinations. **c. Diploma Holders** Applicants should possess at least a second class (lower division) diploma from a recognized institution in any discipline or its equivalent such as the Cisco Certified Network Associate (CCNA) Certification.
University of Namibia (UNAM)	**BSc. Computer Science:** **Faculty of Science entry requirements:** -To register for a B.Sc. course of study, a candidate must hold a valid NSSC Certificate (ordinary or higher) with passes in at least five subjects which add up to 25 points calculated using the UNAM scale. Equivalent qualifications are acceptable. -In addition to the above, admission to the B.Sc. course of study requires

	at least a symbol C on NSSC or equivalent qualification in Mathematics and English. -Students can also gain admission to degree programmes of the Faculty through Mature Age entry as per UNAM's Mature Age Entry regulations contained in the "General Prospectus: Information, Regulations and Fees". -Meeting the minimum admission requirements does not necessarily ensure admission, this depends on places available. -In addition to the Faculty of Science entry requirements, students wishing to major in Computer Science will be expected to pass a Departmental Entry Requirement test. This test is an aptitude test and will in no way affect students that are coming from backgrounds without computer studies
University of Pretoria	**BSc (CS)** To obtain admission to this degree, a candidate should have obtained the following: -A grade 12 certificate with university exemption; and -A minimum M score of 18 in the final Grade 12 examinations; and -At least 60% in Mathematics on Higher Grade in the final Grade 12 examinations; and -At least 60% in Computer Studies on Higher Grade in the final Grade 12 examinations; or by passing the Introduction to Programming module offered by the department (either in a previous year at the university or after attending the module presented during the Summer Term). **BSc IT(Information and Knowledge Systems)** To obtain admission to this degree, a candidate should have obtained the following: - A grade 12 certificate with university exemption; and - A minimum M score of 15 in the final Grade 12 examinations; and - At least 50% in Mathematics on Higher Grade in the final Grade 12 examinations; and - COS130/131 which is presented during the Summer School in January of the first year of registration. A candidate who obtained a minimum of a D symbol for Computer Studies HG in the final Grade 12 examinations, is waived from this requirement.

Appendix E

Undergraduate degree curricula models for Kabarak University.

BSc(Computer Science) in Kabarak University.

7.0 SCHEDULE OF COURSES FOR BACHELOR OF COMPUTER SCIENCE.

Year I Semester I

COURSE CODE	TITLE	C.F.	L	P	TU
MATH 110	Basic Mathematics	3.0	45	0	0
COMP 110	Introduction to Computers Science	3.0	30	30	0
COMP 111	Introduction to Programming	3.0	30	30	0
MATH 111	Vector Geometry	3.0	30	0	30
PHYS 110	Electricity and Magnetism	3.0	30	30	0
COMS 110	Communication Skills	3.0	45	0	0
BIBL 110	Old Testament Survey	3.0	45	0	0
	TOTAL	**18**	**255**	**60**	**30**

Year I Semester II

COURSE CODE	TITLE	C.F.	L	P	TU
MATH 113	Differential Calculus	3.0	30	0	30
PHYS 120	Basic Electronics	3.0	30	30	0
COMP 122	Discrete Structures	3.0	30	0	30
COMP 123	Data Structures	3.0	30	30	0
BIBL 120	New Testament Survey	3.0	30	30	0
COMS 120	Communication Skills II	3.0	30	0	30
	TOTAL	**18**	**180**	**120**	**90**
	YEAR TOTAL	**36**	**435**	**180**	**120**

Year 2 Semester 1

COURSE CODE	TITLE	C.F.	L	P	TU
MATH 123	Probability and Statistics	3.0	30	0	30
MATH 121	Integral Calculus	3.0	30	0	30
COMP 210	Assembly Language Programming	3.0	30	30	0
COMP 212	Object Oriented Programming	3.0	30	30	0
ECON 100	Introduction to economics	3.0	45	0	0
BIBL 110	The redemption Story	3.0	45	0	0
	TOTAL	**18**	**210**	**60**	**60**

Year 2 Semester 2

MATH 211	Linear Algebra	3.0	30	0	30
COMP 220	Operating System	3.0	30	30	0
COMP 222	Telecommunication and Computers	3.0	30	30	0
COMP 223	Digital Circuit Design	3.0	30	0	30
BMGT 214	Business Entrepreneurship	3.0	30	0	30
BIBL 220	Comparative Religion	3.0	45	0	0
	TOTAL	**18**	**195**	**60**	**90**
	YEAR TOTAL	**36**	**405**	**120**	**150**

Year 3 Semester 1

MATH 310	Numerical Analysis	3.0	30	0	30
COMP 311	Design and Analysis of Algorithms	3.0	30	30	0
COMP 312	Computer Networks	3.0	30	30	0
COMP 313	Software Engineering	3.0	30	30	0
COMP 314	Database Management System	3.0	30	30	0
SOCI 100	Introduction to Sociology	3.0	45	0	0
	TOTAL	**18**	**225**	**60**	**30**

Year 3 Semester 2

COMP 320	Object Oriented Analysis Design	3.0	30	30	0
COMP 321	UNIX and C Programming	3.0	30	30	0
COMP 323	Team Project on Software Engineering	3.0	0	60	0
COMP 327	Applied Numerical Methods	3.0	30	30	0
COMP 328	Research Methods In Computer Science	3.0	30	30	0
COMP 329	Evolution of Programming Languages	3.0	30	30	0
COMP 3	Elective I	3.0	30	30	0
	TOTAL	**18**	**180**	**240**	**0**
COMP 330	Industrial Internship	3.0	0	120	0
	YEAR TOTAL	**39**	**405**	**300**	**30**

Year 4 Semester 1

COURSE CODE	TITLE	C.F.	L	P	TU
COMP 411	Computer project I	3.0	0	90	0
COMP 413	Artificial Intelligence	3.0	30	30	0
COMP 414	Introduction to Computer Graphics	3.0	30	30	0
COMP 451	Microprocessor Based System	3.0	30	30	0
COMP 4..	Elective II	3.0	30	30	0
COMP 4..	Elective III	3.0	30	30	0
	TOTAL	**18**	**150**	**240**	**0**

Year 4 Semester 2

COMP 420	Professional Ethics and Information Law	3.0	30	0	0
COMP 421	Software Quality Management.	3.0	45	0	0
COMP 422	Computer Project II	3.0	30	90	0
COMP 423	Seminars in Computer Science.	3.0	45	0	0
COMP 4..	Elective IV	3.0	30	30	0
COMP 4..	Elective V	3.0	30	30	0
	TOTAL	**18**	**210**	**150**	**0**
	YEAR TOTAL	**36**	**360**	**390**	**0**
	PROGRAMME TOTAL	**147**	**1605**	**990**	**300**

ELECTIVES

YEAR III SEMESTER II

Software Engineering

COMP 325	Business Applications Architecture	3.0	30	30	0

Internet Programming

COMP 326	Object-Oriented Programming with Java	3.0	30	30	0

YEAR IV SEMESTER 1

Software Engineering

COMP 441	Software Project Management (Mandatory)	3.0	30	30	0

Plus any other Software Engineering Elective from the following:

COMP 444	Comparative Analyses Modern RAD Tools 3.0	45	0	0	
COMP 446	Seminars on Large Software Project Management	3.0	15	60	0
COMP 447	Strategic Information Systems Management 3.0	30	0	30	

Hardware Electives

COMP 452	Introduction to Robotics 3.0	3.0	30	30	0
COMP 453	Real Time Applications 3.0	3.0	30	30	0
COMP 454	Microprocessor Interfacing	3.0	30	30	0

Internet Programming

COMP 461	Internetworking with TCP/IP (Mandatory)	3.0	15	60	0

Plus any other Internet Programming Elective from the following:

COMP 464	Distributed Systems	3.0	30	30	0
COMP 462	Client Side Programming	3.0	30	30	0
COMP 463	Server Side Programming	3.0	30	30	0
COMP 465	Component-Based Software Development	3.0	30	30	0
COMP 466	Messaging Systems	3.0	30	30	0

ELECTIVE IV AND V

YEAR 4 SEMESTER 2

Select two electives from the group chosen in Year 3 Semester 2. Must not have been done in another semester.

N.B: In Year 3 Semester 2, students are required to select one elective from one of the options viz. Software Engineering, Hardware Systems, or Internet Programming. A further two electives each per semester will be selected from the option chosen in Year 3. All electives in Year 3 Semester 2 and Year 4 Semester 1 & 2.

Key

C.F – Credit Factor
L – Lecture Hours
P – Practical Hours
TU – Total Units

Appendix F
BSc (Information Technology) in Tumaini University

Course Matrix (Summary)

Year of Study	YEAR1		YEAR2		YEAR3	
Semesters	SEMESTER1	SEMESTER2	SEMESTER3	SEMESTER4	SEMESTER5	SEMESTER6
Main Courses	• Introduction to IT, ICT and Computing (6cr*) • Web Page Design and Administration (2cr) • Programming - I: Introduction to Object Oriented Programming (OOP) using Java (3cr) • Introduction to the Ethics of Computing (1.5cr) • **Foundation of Faith and Ethics (1.5cr)**	• Programming - II using Java (3cr) • Programming Project using Java (3cr) • Research Fields of Computer Science (1.5cr) • Database Management Systems (4cr) • **Introduction to Digital Logic and Circuits (2cr)**	• **Introduction to Computer Architecture** (3cr) • Introduction to Computer Networks (2cr) • Discrete Structures (4cr) • Data Structures and Algorithms (4cr) • **Programming Part3 using C-Language (3cr)** • Bachelor's Project and Thesis - I (2cr)	• Network Design and Administration (4cr) • Multimedia (6cr) - Image Technology - Multimedia Production • Software Engineering (3cr) • **Introduction to Operating Systems (3cr)** • Bachelor's Project and Thesis - II (2cr)	• Business and E-Commerce (6cr) - Advanced Website Development for Business - E-commerce • Robotics (2cr) - Artificial Intelligence - Edutainment Robotics • Bachelor's Project and Thesis - III (2cr)	• IT Security (3cr) • Bachelor's Project and Thesis - IV (4cr)
Supporting Courses	-	• Mathematics for Computer Science (2cr)	• Cyber Law (1.5cr)	• Application Projects - I (3cr)	• Application Projects - II (3cr)	• Internship (18cr)**
Other Courses	• Communication Skills –I (2.5cr) • Development Studies (2.5cr)	• Communication Skills – II (2.5cr)	-	-	• Elective Courses (3cr)	-
Total Credit Hour per Academic Year	**38.5cr**		**40.5cr**		**41cr**	
Total Credit Hour per entire program	**120cr**					

* 1cr (credit hour) is equivalent to 18hrs of lectures, practicum, seminars, tests and examinations inclusive
Internship is not done on **SEMESTER6 but on first and second year's long vacations

Appendix G

BSc (Computer Science) In University of Namibia

YEAR	SEMESTER	MODULE TITLE	CODE	PRE-/COREQUISITES
I	I	English Communication & Study Skills	ULCE 3419	University entry requirements
		Basic Mathematics	SMAT3511	Faculty entry requirements
		Computer Literacy	UCLC 3409	University entry requirements
		Programming Fundamentals I	SCMP 3511	Departmental Entry Test
		Fundamentals of Digital Electronics	SCMP 3531	Departmental Entry Test
	II	English for Academic Purposes	ULEA3419	Co-requisite: ULCE3419
		Contemporary Social Issues	UCSI3429	University Entry Requirements
		Programming Fundamentals II	SCMP 3512	SCMP3511 Programming Fundamentals I
		Computer Organization	SCMP 3532	Departmental Entry Test
		Pre-Calculus	SMAT 3512	
II	I	Introduction to Database Systems	SCMP 3611	SCMP 3511 Programming Fundamentals I
		Object Oriented Programming	SCMP 3631	SCMP3511 Programming Fundamentals I
		Software Engineering I	SCMP 3651	SCMP 3511 Programming Fundamentals I
		Mathematics for Computer Science I	SCMP 3671	SMAT 3511 Basic Mathematics
		Compiler Design	SCMP 3621	
	II	Advanced Databases	SCMP 3622	Co-Requisite: SCMP3611 Introduction to Database Systems
		Data Structures and Algorithms	SCMP 3612	Co-Requisite: SCMP 3631 Object Oriented Programming
		Foundations of Data Communications	SCMP 3632	SCMP 3532 Computer Organization
		Software Engineering II	SCMP 3652	Co-Requisite: SCMP 3651 Software Engineering I
		Mathematics for Computer Science II	SCMP 3672	Co-Requisite: SCMP 3671 Mathematics for Computer Science I
III	I	Computer Networks	SCMP 3721	SCMP 3672 Foundations of Data Communication
		Computer Theory	SCMP 3741	SCMP 3652 Mathematics for Computer Science II
		Computer Architecture	SCMP 3761	SCMP 3532 Computer Organization SCMP 3531 Fundamentals of Digital Electronics
		Artificial Intelligence	SCMP 3711	SCMP 3511 Programming Fundamentals I
		Research Methodology I	SCMP 3701	SSTS 3512: Introduction to Statistics
	II	Operating Systems	SCMP 3722	SCMP 3532 Computer Organization Or SCMP 3612 Data Structures and Algorithms
		Human Computer Interaction and Computer Ethics	SCMP 3742	SCMP 3632 Software Eng II
		Computer Graphics	SCMP 3762	SCMP 3612 Data Structures and Algorithms
		Internet Technologies and Applications	SCMP 3712	Co-Requisite: SCMP 3711 Computer Networks
		Research Methodology II	SCMP 3702	Co-Requisite: SCMP 3701 Research Methodology I

IV	I & II	Research Project	SCMP 3810	Pass all Third Year Modules
	I	Network Systems Security	SCMP 3821	SCMP 3711 Computer Networks
		Wireless and Mobile Computing	SCMP 3841	SCMP 3711 Computer Networks
		Choose Any Two Modules (Subject to Dept Approval)		
		Software Project Management	SCMP 3801	SCMP 3742 Human computer Interaction and Computer Ethics
		Numerical Methods	SCMP 3811	SCMP 3672 Mathematics for Computer Science II Or CEEM 3672 Intermediate Mathematical Economics
		Operations Research	SCMP 3831	SCMP 3672 Mathematics for Computer Science II Or CEEM 3672 Intermediate Mathematical Economics
		Distributed Systems	SCMP 3851	SCMP 3711 Computer Networks SCMP 3612 Data Structures and Algorithms
		Advanced Computer System Design	SCMP 3871	SCMP 3532 Computer Organization SCMP 3751 Computer Architecture
	II	Field Attachment	SCMP 3802	Pass all Third Year Modules
		Data Warehousing and Data Mining	SCMP 3822	SCMP 3622 Advanced Databases
		Choose Any Two Modules (Subject to Dept Approval)		
		Digital Libraries	SCMP 3862	SCMP 3622 Advanced Databases
		Network Administration	SCMP 3852	SCMP 3711 Computer Networks SCMP 3722 Operating Systems
		Real Time Multimedia	SCMP 3812	SCMP 3742 Human computer Interaction and Computer Ethics
		Entrepreneurship and Management of IT Systems	SCMP 3832	SCMP 3742 Human computer Interaction and Computer Ethics
		Database Programming	SCMP 3722	SCMP 3512 Programming Fundamentals II SCMP 3622 Advanced Databases
		Expert Systems	SCMP 3852	SCMP 3771 Artificial Intelligence

Appendix H

BSc (Computer Science) in Makerere University

Bachelor of Science in Computer Science - Curricullum | Course Outline | Back To Course

Code	Name	LH	PH	TH	CH	CU	Type
Year 1							
Semester I							
CSK 1101	Communication Skills	45	30	0	60	4	Core
CSC 1100	Computer Literacy	40	30	0	60	4	Core
CSC 1101	Computers	45	0	0	45	3	Core
CSC 1102	Computational Mathematics I	45	0	30	60	4	Core
CSC 1103	Solution Methods in Optimization	45	0	30	60	4	Core
Semester II							
CSC 1200	Programming Methodology	45	0	30	60	4	Core
CSC 1201	Computational Mathematics II	45	0	30	60	4	Core
CSC 1202	Principles of Programming	45	0	30	60	4	Core
CSC 1203	Information Systems	45	0	0	45	3	Core
CSC 1204	Research Methodology	45	0	30	60	4	Core
CSC 1301	Practical Skills Development	0	120	0	60	4	Core
CSC 1302	CCNA Semester I and II(Audited Course)	40	0	30	60	0	Core
Year 2							
Semester I							
CSC 2100	Data Structures and Algorithms	45	0	30	60	4	Core
CSC 2101	Computer Programming	45	0	30	60	4	Core
CSC 2102	Systems Programming	45	0	30	60	4	Core
CSC 2103	Numerical Methods	45	0	30	60	4	Core
CSC 2104	Complexity and Computability	45	0	0	45	3	Elective
CSC 2105	Information Technology & Society	45	0	0	45	3	Elective
CSC 2106	Cryptology and Coding Theory	45	0	0	45	3	Elective
CSC 2301	Industrial Training	0	0	0	0	0	Core
CSC 3204	Selected Topics in Computer Science II	0	0	0	0	0	Core

Semester II

CSC 2200	Operating Systems	45	0	30	60	4	Core
CSC 2201	Computer Architecture	45	0	0	45	3	Core
CSC 2202	Systems Analysis and Design	45	0	30	60	4	Core
CSC 2203	Database Languages	45	0	30	60	4	Core
CSC 2204	Research Design and Implementation	30	0	0	30	2	Core
CSC 2205	Principles of Programming Languages	45	0	0	45	3	Elective
CSC 2207	Parallel Algorithms	45	0	30	60	4	Elective
CSC 2208	Selected Topics in Computer Science I	45	0	0	45	3	Core
CSC 2302	CCNA Semester III and IV (Audited Course)	0	0	0	0	4	Core
CSC 2206	Artificial Intelligence	0	0	0	0	0	Elective

Year 3

Semester I

CSC 3100	Database Management Systems	0	0	0	0	0	Core
CSC 3102	Modelling and Optimisation	0	0	0	0	3	Core
CSC 3103	User Interface Design	0	0	0	0	0	Elective
CSC 3104	Program Translation	0	0	0	0	0	Elective
CSC 3105	Computer Graphics	0	0	0	0	0	Elective
CSC 3106	Distributed Systems Development	0	0	0	0	0	Elective
CSC 3107	Database Systems	0	0	0	0	0	Core
CSC 3108	E-Commerce	0	0	0	0	0	Elective
CSC 3109	Computer networks	0	0	0	0	0	Core
CSC 3203	Numerical Analysis	0	0	0	0	0	Elective

Semester II

CSC 3101	Software Engineering	0	0	0	0	0	Core
CSC 3200	Computer Networks and Data Communication	0	0	0	0	0	Core
CSC 3201	B.Sc. CSC. Project	0	0	0	0	4	Core
BIT 3204	Enterprise Network Management	0	0	0	0	0	Core
CSC 3202	Concepts of CAD/CAM	0	0	0	0	0	Elective
BIT 3200	Business Intelligence and Data Warehousing	0	0	0	0	0	Elective

BSc (Information Technology) in Makerere University

Bachelor of Information Technology - Curricullum | Course Outline | Back To Course

Code	Name	LH	PH	TH	CH	CU	Type
Year 1							
Semester I							
CSK 1101	Communication Skills	45	30	0	60	4	Core
CSC 1100:	Computer Literacy	45	30	0	60	4	Core
BIT 1100	Website Development and Internet Technology	30	30	0	45	3	Core
BIT 1101	Business Communication and Report Writing	45	0	0	45	3	Core
BIT 1102	Communications Technology and the Internet	45	0	0	45	3	Core
BIT 1103	Basic Management Skills	45	0	0	45	3	Core
Semester II							
CSC 1202:	Principles of Programming	45	0	30	60	4	Core
CSC 1203:	Information Systems	45	0	0	45	3	Core
BIT 1200	Information Technology	45	0	0	45	3	Core
BIT 1201	System Administration	30	30	0	45	3	Core
BIT 1203	Business Applications Programming	45	0	30	60	4	Core
BIT 1301	Practical Skills Development	0	120	0	60	4	Core
CSC 1302	CCNA Semester I and II(Audited Course)	45	0	30	60	0	Elective
BIT 2106	Scripting Languages	45	0	0	45	3	Core
Year 2							
Semester I							
BIT 2100	Information Systems Development	45	0	30	60	4	Core
BIT 2101	Information Systems Management	45	0	0	45	3	Core
BIT 2102	Electronic Commerce I	45	30	0	60	3	Core
BIT 2103	Event-Driven Programming	45	0	0	45	3	Elective
BIT 2104	Object Oriented Programming	45	0	0	45	3	Elective
BIT 2105	Electronic Media Systems and Multimedia	45	0	0	45	3	Elective
Semester II							
CSC 2202:	Systems Analysis and Design	45	0	30	60	4	Core
CSC 2203:	Database Languages	45	0	30	60	4	Core
CSC 2204:	Research Design and Implementation	30	0	0	30	2	Core
BIT 2200	Electronic Commerce II	45	0	30	60	4	Core
BIT 2201	Marketing in the Information Technology Sector	45	0	0	45	3	Core

BIT 2202	Client-Server Programming for Applications	45	0	30	60	4	Elective
BIT 2203	Systems Security	45	0	30	60	4	Elective
BIT 2204	Networking Technologies	45	30	0	60	4	Elective
BIT 2301:	Industrial Training	0	120	0	60	4	Core
CSC 2302	CCNA Semester III and IV(Audited Course)	45	120	30	60	0	Elective
Year 3							
Semester I							
CSC 3100:	Database Management Systems	45	0	30	60	4	Core
CSC 3101:	Software Engineering	45	0	30	60	4	Elective
CSC 3103:	User Interface Design	45	30	0	60	4	Elective
CSC 3105:	Computer Graphics	45	0	30	0	4	Elective
BIT 3100	Dynamic Website and Internet Technology	45	0	0	43	3	Core
BIT 3101	Information Technology Project Management	45	0	0	43	3	Core
BIT 3103	Strategic Management	45	0	0	43	3	Core
Semester II							
BIT 1202	Entrepreneurship and Business	45	0	0	45	3	Core
CSC 3200:	Computer Networks and Data Communication	45	30	0	60	4	Core
BIT 3200	Business Intelligence and Data Warehousing	45	30	0	60	4	Core
BIT 3201:	BIT Project	0	0	0	0	4	Core
BIT 3202	Network Computing	45	0	30	60	4	Elective
BIT 3203	Mobile Networks and Computing	45	0	30	60	4	Elective
BIT 3204	Enterprise Network Management	45	0	30	60	4	Elective
BIT 3205	Database (DB) Programming	45	0	30	60	4	Core

Key

LH – Lecture Hours
PH – Practical Hours
TH – Tutorial Hours
CH – Contact Hours
CU – Credit Units

Appendix I

BSc (Computer Science) in University of Pretoria

FIRST YEAR OF STUDY (at least 125 credits and maximum of 155)				
Code	**Module**	**Prerequisite**	**Credits**	**Period**
Fundamental modules (at least 8 credits)				
Pass an exemption examination in CIL 111 **or**				
CIL 111	Computer Literacy **and**		4	S1
CIL 121	Information Literacy		4	S2
Pass an academic literacy test **or**				
EOT 110	Academic Literacy		6	S1
EOT 120	Academic Literacy		6	S2
Core modules for year-level 1 (84 credits)				
COS 110	Program Design: Introduction	See IT.2(d)	16	S1
COS 151	Introduction to Computer Science		8	S1
COS 140	Netcentric Computer Systems	COS 110 or COS 130/COS 131	16	S2
EOS 284	Computer Architecture	COS 110 or COS 130/COS 131	12	S2
WTW 114	Calculus	Par 1.2 – Natural Sciences **or** [IT.2(b)]	16	S1
WTW 115	Discrete Structures	Par 1.2 – Natural Sciences	8	S1
WTW 126	Linear Algebra	Maths Gr 12 HG (D)	8	S2
Elective modules for year-level 1: A minimum of 24 credits from the following required elective module groups should be selected:				
FRK 111 **and**	Financial Accounting		10	S1
FRK 121 **and**	Financial Accounting	FRK 111 GS	12	S2
INF 181	Informatics	IT.2 (d)	3	S1 or 2
OBS 114	Business Management		10	S1
OBS 124	Business Management	OBS 114 GS	10	S2
KOB 181	Communications Management	-	5	Q1, 2/4
INL 110	Information Science: Introduction to Information Science	-	12	S1
INL 120	Information Science: Organisation and Representation of Information		12	S2
WST 111	Mathematical Statistics	Par 1.2 – Natural Sciences **or** [IT.2(b)]	16	S1
WST 121	Mathematical Statistics	WST 111 GS	16	S2

WTW 123 WTW 128 WTW 152	Numerical Analysis Calculus Mathematical Modelling	WTW 114 GS WTW 114 GS Par. IT.2(b)	8 8 8	S2 S2 S1
Additional elective credits from the following module groups may be taken at any year-level: 16 credits for COS 130, for candidates who did not initially comply with the entry requirements of COS 110. Any modules at year-level 1 from Chemistry Any modules at year-level 1 from Mathematics Any modules at year-level 1 from Physics				
FIL 120	Philosophy		12	S2
INF 153	Informatics	Par IT.2(g)	5	S1
INF 163	Informatics	INF 153 GS	5	S2

SECOND YEAR OF STUDY (at least 130 credits)				
Code	**Module**	**Prerequisites**	**Credits**	**Period**
Core modules for year-level 2 (90 credits)				
COS 212	Data Structures and Algorithms	COS 214 GS	16	S2
COS 214	Design Patterns	COS 110 or [(COS 130/COS 131) and COS 140]	16	S1
COS 222	Operating Systems	COS 110 or [(COS 130/COS 131) and COS 140]	16	S1
COS 226	Concurrent Systems	COS 110	16	S2
INF 214	Informatics	CIL 111, 121	14	S1
WTW 285	Discrete Structures	WTW 115	12	S2
Elective modules for year-level 2 A minimum of 40 required elective credits from the following module groups should be selected				
ERS 220	Digital Systems		16	S2
INL 240	Information Science: Social and ethical impact		20	S1
WTW 218 WTW 220 WTW 211 WTW 221	Calculus Analysis Linear Algebra Linear Algebra	WTW 114 .101 **and** WTW 128 WTW 114/WTW 101, WTW 128 WTW 211	12 12 12 12	S1 S2 S1 S2
FBS 210 **and** FBS 220	Financial Management Financial Management **or**	FRK 111, 121 FRK 111, 121	16 16	S1 S2
FRK 211 **and** FRK 221	Financial Accounting Financial Accounting	FRK 111,121, Reg 1.2 (d) FRK 211 GS	16 16	S1 S2
GGY 283 GIS 220	Introductory GIS Geographic data analysis	-	12 12	S1/S2 S2
INF 271	Informatics	CIL 111, 121 INF 163, 164 or LP	14	Year

Additional elective credits from the following module groups may be taken at any year-level: Any modules at year-level 2 from Mathematics Any modules at year-level 2 from Mathematical Statistics Any modules at year-level 2 from Physics				
FIL 220	Social and political philosophy	-	20	S2
INL 210	Information Science: Information seeking and retrieval	CIL 121	20	S1
IMY 210^	Multimedia: Advanced Mark-up Languages (1)		16	S1
IMY 220^	Multimedia: Advanced Mark-up Languages (2)	IMY 210	16	S2
IMY 211^	Multimedia: Multimedia and hypermedia theory		20	S1
KOB 210	Communication Management	-	16	S1
KOB 220	Communication Management	-	16	S2
Note: ^ Requires departmental selection				

THIRD YEAR OF STUDY (minimum 144 credits)				
Code	**Module**	**Prerequisites**	**Credits**	**Periods**
Fundamental modules for year-level 3 (99 credits):				
COS 301	Software Engineering	COS 212	27	Year
At least **four** of the following semester modules:				
Note: The semester in which these modules are offered may vary from year to year.				
COS 314	Artificial Intelligence	COS 214	18	S1
COS 326	Databases	INF 214 or LP	18	S2
COS 332	Computer Networks	COS 140	18	S1
COS 333	Programming Languages	COS 110	18	S1
COS 341	Compiler Construction	COS 212	18	S2
COS 343	Trends in IT	COS 110 **or** (COS 130/COS 131 and COS 140)	18	S2
COS 344	Computer Graphics	COS 214 **and** WTW 126	18	S2
EMK 310	Microprocessors	ERS 220GS or LP	16	S1
Elective modules for year-level 3: Modules for a minimum of 24 required elective credits should be selected from the following module groups: Any 2 computer science modules not selected under the list of core modules for year-level 3. Any module group of at least 36 credits at year-level 3 from Mathematics that includes WTW 385.				
GIS 310 GIS 320	Geographic Information Systems Spatial Analysis	GGY 283 GIS 310	24 24	S1 S2
Note: * Admission to these modules requires departmental selection.				
IMY 310	Multimedia: Human-computer interaction	*	30	S1
IMY 320	Multimedia: Trends	*	30	S2

<table>
<tr><td colspan="5">Select additional elective modules for the remainder of credits from the following:
Any additional modules at year-level 3 in Computer Science
Any additional modules at year-level 3 in Mathematics
Any additional modules at year-level 3 Mathematical Statistics</td></tr>
<tr><td>INF 324</td><td>Informatics</td><td>INF 261, 262, 271, 272, or LP</td><td>15</td><td>S2</td></tr>
<tr><td>FBS 300</td><td>Financial Management</td><td>FBS 200</td><td>40</td><td>Year</td></tr>
<tr><td colspan="5">or</td></tr>
<tr><td>FBS 310
and
FBS 320
or</td><td>Financial Management</td><td>FBS 210, 220 with a GS in the other</td><td>20 each</td><td>S1

S2</td></tr>
<tr><td>FRK 311
and
FRK 321</td><td>Financial Accounting</td><td>FRK 211,221
FRK 311GS</td><td>20 each</td><td>S1

S2</td></tr>
<tr><td colspan="5">At most TWO INL 3** / IMY 3** modules selected from the IMY 3** core modules and from the list below, provided that the IMY3** modules have not been selected as core modules.</td></tr>
<tr><td>INL 310</td><td>Information Science: Information Organisation</td><td>-</td><td>30</td><td>S2</td></tr>
<tr><td>INL 320</td><td>Information Science: Information and knowledge management</td><td>-</td><td>30</td><td>S1</td></tr>
<tr><td>INL 360</td><td>Information Science: Socio-political aspects of information</td><td>-</td><td>30</td><td>S2</td></tr>
</table>

BSc. IT (Information and Knowledge Systems) in University of Pretoria

FUNDAMENTAL MODULES				
Code	**Module**	**Prerequisites**	**Credits**	**Period**
Year-level 1 (at least 8 credits)				
Pass an exemption examination in CIL 111 **or**				
CIL 111	Computer Literacy and		4	S1
CIL 121	Information Literacy		4	S2
Pass an exemption examination in Academic Literacy **or**				
EOT 110	Academic Literacy		6	S1
EOT 120	Academic Literacy		6	S2
Year-level 2 (8 credits)				
JCP 202	Community-based Project		8	Year

CORE MODULES				
Code	**Module**	**Prerequisites**	**Credits**	**Period**
Year-level 1 (64 credits)				
COS 110	Program Design: Introduction	See IT.2(d)	16	S1
COS 140	Netcentric Computer Systems	COS 110 or COS 130/ COS 131	16	S2
COS 151	Introduction to Computer Science		8	S1
WTW 114	Calculus	Par 1.2 – Natural Sciences	16	S1
WTW115	Discrete Structures	Par 1.2 – Natural Sciences	8	S1
Year-level 2 (90 credits)				
COS 212	Data Structures and Algorithms	COS 214 GS	16	S2
COS 214	Design Patterns	COS 110 or (COS 130/ COS 131 and COS 140)	16	S1
COS 222	Operating Systems	COS 110 or (COS 130/ COS 131 and COS 140)	16	S1
COS 226	Concurrent Systems	COS 110	16	S2
INF 214	Informatics	CIL 111 and CIL 121	14	S1
WTW 285	Discrete Structures	WTW 115	12	S2
Year-level 3 (27 credits)				
COS 301	Software Engineering	COS 212	27	Year

ELECTIVE MODULES Select **one** of the following **options**:				
Applied Mathematics option				
Code	**Module**	**Prerequisites**	**Credits**	**Period**
Year-level 1 (50 credits)				
STK 110	Statistics 110	Reg 1.2(j)	13	S1
STK 120	Statistics 120	STK 110 GS	13	S2
WTW 123	Numerical Analysis	WTW 114 GS/101GS	8	S2
WTW 126	Linear Algebra	Par 1.2 - Natural Sciences	8	S2
WTW 128	Calculus	WTW 114/101	8	S2
Year-level 2 (72 credits)				
WST 211	Mathematical statistics	WST 111, 121, WTW 114 GS /101 GS, WTW 126 GS/WTW 128 GS	24	S1
WST 221	Mathematical statistics	WST 211 GS	24	S2
WTW 211	Linear Algebra	WTW 126	12	S1
WTW 218	Calculus	WTW 114/101, WTW 128	12	S1
Year-level 3 (108 credits)				
Any 3 other COS module on year-level 3			54	
WTW 354	Financial Engineering	WST 211, WTW 211, WTW 218	18	S1
WTW 383	Numerical Analysis	WTW 114/101, WTW 128, WTW 211	18	S2
WTW 389	Geometry	WTW 211	18	S2

Bioinformatics option				
Code	**Module**	**Prerequisites**	**Credits**	**Period**
Year-level 1 (64 credits)				
BME 120	Biometry		16	S2
BOT 161	Plant Biology	MLB 111GS or LP	8	S2
GTS 161	Introductory Genetics	MLB 111GS or LP	8	S2
MBY 161	Introduction to Microbiology		8	S2
MLB 111	Molecular and cell biology	Physical Science HG(D)	16	S1
WTW 126	Linear Algebra	Par 1.2 – Natural Sciences	8	S2
Year-level 2 (36 credits)				
GTS 251	Organisation of Genes and Chromosomes	GTS 161GS	12	S1
GTS 261	Genetic Analysis and Manipulation	GTS 161GS or LP	12	S2
MBY 251	Growth diversity and control/bacteria	MBY 161 GS	12	S1
MBY 261	Growth activity and control/fungi	MBY 161	12	S2
Year-level 3 (126 credits)				
BIF 310	Bioinformatics	WTW 114, BME 120 and GTS 251	9	S1
BIF 320	Bioinformatics	BIF 310	18	S2
COS 314	Artificial Intelligence	COS 214	18	S1
COS 326	Database Systems	INF 214 or LP	18	S2
COS 344	Computer Graphics	COS 214 and WTW 126	18	S2
Choice of either				
GTS 353	Population Genetics	GTS 251GS and GTS 261GS or LP	18	S1
and	**and**			
GTS 363	Evolutionary and Phylo-Genetics	GTS 353GS/LP	18	S2
OR				
GTS 352	Genomes	{GTS 251 GS} and {GTS261 GS} or {PHOD}	18	S1
and	**and**			
GTS 366	Plant Genetics and Biotechnology	{GTS 251GS}, {GTS 261 GS} or {PHOD} and {GTS 351 GS} is recommended and {GTS 352 GS is recommended}	18	S2

Geographical Information Systems option				
Code	**Module**	**Prerequisites**	**Credits**	**Period**
Year-level 1 (42 credits)				
GGY 132	Cartographic skills	(Maths HG(E) or SG(D)) or Geography HG(D)	4	S1
GGY 156	Introduction to Human Geography		6	Q4
GGY 157	Introduction to Environmental Sciences		6	Q1
GGY 162	Remote sensing	(Maths HG(E) or SG(D)) or Geography HG(D)	4	S2
GGY 166	SA* Global Geomorphology		6	Q3
GMC 110	Cartography	GGY132	8	S1
WTW 126	Linear Algebra	Par 1.2 - Natural Sciences	8	S2
Year-level 2 (36 credits)				
GGY 283	Introductory GIS		12	S1
GIS 220	Geographical Data Analysis		12	S2
GMC 210	Cartography	GMC 110	12	S1
Year-level 3 (126 credits)				
COS 326	Database Systems	INF 214 or LP	18	S1
COS 344	Computer Graphics	COS 214 **and** WTW 126	18	S2
One other COS module at year-level 3			18	
GIS 310	Geographical Information Systems	GGY 283 or LP	24	S1
GIS 320	Spatial Analysis	GIS 310 or LP	24	S2
GMC 310	Cartography	GMC 210	24	S1

IT and Enterprises option				
Code	**Module**	**Prerequisites**	**Credits**	**Period**
Year-level 1 (53 credits)				
BEM 110	Marketing Management		10	S1
BEM 121	Marketing Management		10	S2
OBS 114	Business Management		10	S1
OBS 124	Business Management	OBS 114 GS	10	S2
STK 110	Statistics	Reg.1.2(j)	13	S1
Year-level 2 (38 credits)				
BPE 251	Business Ethics		6	S1
OBS 210	Logistics Management	OBS 114 or OBS 124 with GS in the other	16	S1
OBS 220	Project Management	OBS 114 or OBS 124 with GS in the other	16	S2
Year-level 3 (134 credits)				
COS 326	Database Systems	INF 214 or LP	18	S2
COS 343	Trends in IT	COS 110 or (COS 130/ COS 131 and COS 140)	18	S2
One other COS module on year-level 3			18	
OBS 311	Entrepreneurship	OBS 114	20	S1
OBS 321	Entrepreneurship	OBS 311 GS	20	S2

One of the following combinations to be taken either in 2nd or 3rd year				
OBS 315 **and** OBS 325	E-business **and** E-commerce	OBS 114 or OBS 124 with GS in the other OBS 114 or OBS 124 with GS in the other	20 20	S1 S2
OR				
OBS 359 **and** OBS 369	International Business Management **and** International Financial Management	OBS 114 or 124 with GS in the other OBS 114 or 124 with GS in the other; OBS 359 GS	20 20	S1 S2
OR				
OBS 310 **and** OBS 320	Human Resource Management **and** Business Management	OBS 114 or OBS 124 with GS in the other OBS 114 or OBS 124 with GS in the other	20 20	S1 S2

IT and Law option				
Code	**Module**	**Prerequisites**	**Credits**	**Period**
Year-level 1 (56 credits)				
FIL 110	Philosophy		12	S1
KRG 110	Commercial Law		10	S1
KRG 120	Commercial Law	Admission to examination in KRG 110	10	S2
KRM 110	Criminology		12	S1
KRM 120	Criminology		12	S2
Year-level 2 (52 credits)				
KRG 200	Commercial Law	Admission to examination in KRG 120	32	Year
KRM 210	Criminology		20	S1
Year-level 3 (124 credits)				
Any 3 other COS modules at year-level 3			54	
KRM 310	Criminology	KRM 110,220	30	S1
KRM 320	Criminology	KRM 210,220	30	S2
KUB 420	Cyber Law	The head of department may set the module prerequisites.	10	S2

IT and Music option				
Code	**Module**	**Prerequisites**	**Credits**	**Period**
Year-level 1 (74 credits)				
DFK 110	Drama and Film Studies		12	S1
EOS 284	Computer Architecture	COS 110 or COS 130/131	12	S2
MOP 172	Music Literacy		30	Year
MPE 170	Music Education	Closed - Requires departmental selection	10	Year
WTW 126	Linear Algebra	Par 1.2 - Natural Sciences	8	S2
WTW 128	Calculus	WTW 114 GS/101 GS	8	S2
Year-level 2 (63 credits)				
DFK 220	Realism and the contruction of reason		20	S2
ERS 220	Digital Systems		16	S2
MPE 270	Music Education	Closed - Requires departmental selection	15	Year
WTW 218	Calculus	WTW 114/101, WTW 128	12	S1
Year-level 3 (103 credits)				
Any 3 other COS modules at year-level 3			54	
EMK 310	Microprocessors	ERS 220 or LP	16	S1
MCS 300	Music Technology	Closed - Requires departmental selection	15	Year
WTW 386	Partial Differential Equations	WTW 218 and WTW 286	18	S1

Operational Research option				
Code	**Module**	**Prerequisites**	**Credits**	**Period**
Year-level 1 (64 credits)				
FRK 111and FRK 121	Financial Accounting Financial Accounting	 FRK 111 GS	10 12	S1 S2
STK 110	Statistics	Reg 1.2 (j)	13	S1
STK 120	Statistics	STK 110 GS	13	S2
WTW 126	Linear Algebra	Par 1.2 - Natural Sciences	8	S2
WTW128	Calculus	WTW 114 GS/101 GS	8	S2
Year-level 2 (28 credits)				
BAN 222	Industrial Analysis	BES 210 GS	8	S2
BES 210	Engineering Statistics	None	8	S1
WTW 211	Linear Algebra	WTW 126	12	S1
Year-level 3 (129 credits)				
BOZ 311	Operational Research	BAN 222	16	S1
BOZ 321	Operational Research	BOZ 311	16	S2
COS 314	Artificial Intelligence	COS 214	18	S1
COS 326	Database Systems	INF 214 or LP	18	S2
One other COS module on year-level 3			18	
SOC 353	Industrial Sociology	None	15	Q4
WTW 383	Numerical Analysis	WTW 114/101, WTW 128, WTW 211	18	S2

Philosophy option				
Code	**Module**	**Prerequisites**	**Credits**	**Period**
Year-level 1 (52 credits)				
FIL 110	Philosophy		12	S1
FIL 120	Philosophy		12	S2
SCI 154/164	Exploring the Universe		16	S1/S2
SLK 120	Psychology		12	S2
Year-level 2 (60 credits)				
FIL 210	Modern and postmodern philosophy		20	S1
FIL 220	Social and political philosophy		20	S2
INL 240	Information Science: Social and ethical impact		20	S1

Year-level 3 (129 credits)				
Any 3 other COS modules at year-level 3			54	
FIL 310	Philosophical anthropology and Cognitive philosophy		30	S1
FIL 320	Philosophical hermeneutics		30	S2
FIL 355	Ethics		15	Q3

Psychology option				
Code	**Module**	**Prerequisites**	**Credits**	**Period**
Year-level 1 (48 credits)				
KRM 110	Criminology		12	S1
KRM 120	Criminology		12	S2
SLK 110	Psychology		12	S1
SLK 120	Psychology		12	S2
Year-level 2 (40 credits)				
KRM 210	Criminology		20	S1
SLK 220	Psychology		20	S2
Year-level 3 (144 credits)				
Any 3 other COS modules at year-level 3			54	
KRM 310	Criminology	KRM 210,220	30	S1
SLK 310	Psychology		30	S1
SLK 320	Psychology		30	S2

Software Development option				
Code	**Module**	**Prerequisites**	**Credits**	**Period**
Year-level 1 (48 credits)				
COS 130	Introduction to Programming	IT2(g)	16	S1
FRK 111 and FRK 121	Financial Accounting Financial Accounting	 FRK 111GS	10 12	S1 S2
INF 154	Informatics	IT.2(g)	5	S1
INF 164	Informatics	INF 154GS	5	S2
Year-level 2 (53 credits)				
INF 261	Informatics	INF 214GS	7	S2
INF 272	Informatics	INF 163, INF 164	14	Year
IMY 210^	Multimedia: Advanced Markup Languages (1)		16	S1
IMY 220^	Multimedia: Advanced Markup Languages (2)	IMY 210	16	S2
Year-level 3 (99 credits)				
COS 326	Database Systems	INF 214 or LP	18	S2
COS 333	Programming Languages	COS 110	18	S1

One other COS module at year-level 3			18	
INF 354	Informatics		15	S1
IMY 310^	Multimedia: Human-computer interaction		30	S1