STUDY GUIDE for

BSIT & BSIS

Capstone Project

and BSCS **Thesis**

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STUDY GUIDE

1 COURSE OVERVIEW

SPECIFIC LEARNING OUTCOMES

At the end of this lesson, the student is expected to:

- Relate the course learning outcomes to the realization of the vision, mission, goal, and objectives
- Introduce the integration of the different courses, knowledge and competencies
- Discuss research and design, roles and responsibilities, thrust and priorities, and general thesis format; and
- Encourage students to collaborate based on their chosen topics for capstone project
- Define research in relation to its goals and purpose
- Demonstrate the characteristics of a good research problem as well as that of a good design

BICOL UNIVERSITY VISION, MISSION, CORE VALUES, QUALITY POLICY

VISION. A world-class university producing leaders and change agents for social transformation and development.

MISSION. Give professional and technical training, and provide advanced and specialized instruction in literature, philosophy, the sciences, and arts besides providing for the promotion of scientific and technological researches (RA5521, Section 3.0).

CORE VALUES. Scholarship, Leadership, Character, Service

QUALITY POLICY. Bicol University commits to continually strive for excellence in instruction, research and extension by meeting the highest level of clientele satisfaction and adhering to quality standards and applicable statutory and regulatory requirements.

INSTITUTIONAL LEARNING OUTCOMES

Every BU graduate should:

1. Demonstrate critical thinking and integrative skills to solve problems and to support lifelong learning;
2. Communicate effectively and appropriately orally and in writing for various purposes with the responsible use ICT tools;
3. Collaborate with diverse people ethically and with mastery of knowledge and skills in given disciplines; and
4. Create knowledge and innovation to promote inclusive development as well as globalization.

PROGRAM LEARNING OUTCOMES[1]

Graduate of BSCS should:

1. Apply knowledge of computing fundamentals, knowledge of a computing specialization, and mathematics, science, and domain knowledge appropriate for the computing specialization to the abstraction and conceptualization of computing models from defined problems and requirements
2. Identify, analyze, formulate, research literature, and solve complex computing problems and requirements reaching substantiated conclusions using fundamental principles of mathematics, computing sciences, and relevant domain disciplines
3. An ability to apply mathematical foundations, algorithmic principles and computer science theory in the modeling and design of computer-based systems in a way that demonstrates comprehension of the tradeoffs involved in design choices
4. Knowledge and understanding of information security issues in relation to the design, development and use of information systems
5. Design and evaluate solutions for complex computing problems and design and evaluate systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations
6. Create, select, adapt and apply appropriate techniques, resources and modern computing tools to complex computing activities with an understanding of the limitations to accomplish a common goal
7. Function effectively as an individual and as a member or leader in diverse teams and in multidisciplinary settings
8. Communicate effectively with the computing community and with society at large about complex computing activities by being able to comprehend and write effective reports, design documentation, make effective presentations, and give and understand clear instructions
9. An ability to recognize the legal, social, ethical and professional issues involved in the utilization of computer technology and be guided by the adoption of appropriate professional, ethical and legal practices
10. Recognize the need, and have the ability, to engage in independent learning to continual development as a computing professional

Graduate of BSIS should:

1. Apply knowledge of business processes, computing, mathematics and social sciences appropriate to Information Systems
2. Analyze a problem, identify and define the computing requirements with respect to organizational factors appropriate to its solution and plan strategies for their solution
3. Evaluate information systems in terms of general quality attributes and possible trade-offs presented within the given requirement

[1] CHED CMO No. 25, series of 2015

4. Design, implement, and evaluate information systems, processes, components, or programs and to source cost-benefit efficient alternatives to meet desired needs, goals and constraints
5. Use knowledge and understanding of enterprises in modelling and design of information systems
6. Deploy and use effectively skills, tools and techniques necessary for information systems practice
7. Function effectively on teams (recognizing the different roles within a team and different ways of organizing teams) to accomplish a common goal
8. Communicate effectively with a range of audiences. Communication skills includes technical writing, presentation and negotiation, and numeracy.
9. Recognize the legal, social, ethical and professional issues involved in the exploitation of computer technology and be guided by the adoption of appropriate professional, ethical and legal practices both in the local and global community
10. Recognize the need for and engage in an independent and life-long learning, planning, self-learning and improving performance as the foundation for on-going professional development

Graduate of BSIT should:

1. Apply knowledge of computing, science, and mathematics appropriate to the discipline
2. Understand best practices and standards and their applications
3. Analyze complex problems, and identify and define the computing requirements appropriate to its solution
4. Identify and analyze user needs and take them into account in the selection, creation, evaluation and administration of computer-based systems
5. Design, implement, and evaluate computer-based systems, processes, components, or programs to meet desired needs and requirements under various constraints
6. Integrate IT-based solutions into the user environment effectively
7. Apply knowledge through the use of current techniques, skills, tools and practices necessary for the IT profession
8. Function effectively as a member or leader of a development team recognizing the different roles within a team to accomplish a common goal
9. Assist in the creation of an effective IT project plan
10. Communicate effectively with the computing and with society at large about complex computing activities through logical writing, presentations and clear instructions
11. Analyze the local and global impact of computing information technology on individuals, organizations, and society
12. Understand professional, ethical, legal, security and social issues and responsibilities in the utilization of information technology
13. Recognize the need for and engage in planning self-learning and improving performance as a foundation for continuing professional development

See **Appendix A** for CHED CMO No. 25, series of 2015.

COURSE DESCRIPTION[2]

This course function as terminal project requirements that would not only demonstrate a student's comprehensive knowledge on the area of study and research methods used but also allow them to apply the concepts and methods to a specific problem in their area of specialization. BS Computer Science students are required to complete a thesis that is focused on the theories and concepts of computing in the form of a scientific work. A Computer Science thesis must be anchored on Computer Science principles. BS Information Systems students must complete a project such as business application development, or an Information Systems plan. An Information Systems Capstone Project focuses on business processes and the implications of introducing a computing solution to a problem. BS Information Technology students must complete a project such as software/system development with emphasis on the IT infrastructure, or an IT management project. An Information Technology Capstone Project focuses on the infrastructure, application, or processes involved in implementing a computing solution to a problem.

WHAT IS RESEARCH?[3]

Research is the process of discovering new knowledge. This knowledge can be either the development of new concepts or the advancement of existing knowledge and theories, leading to a new understanding that was not previously known.

While research can be carried out by anyone and in any field, most research is usually done to broaden knowledge in the physical, biological, and social worlds. This can range from learning why certain materials behave the way they do, to asking why certain people are more resilient than others when faced with the same challenges.

The use of 'systematic investigation' in the formal definition represents how research is normally conducted – a hypothesis is formed, appropriate research methods are designed, data is collected and analysed, and research results are summarised into one or more 'research conclusions'. These research conclusions are then shared with the rest of the scientific community to add to the existing knowledge and serve as evidence to form additional questions that can be investigated. It is this cyclical process that enables scientific research to make continuous progress over the years; the true purpose of research.

What is the Purpose of Research

From weather forecasts to the discovery of antibiotics, researchers are constantly trying to find new ways to understand the world and how things work – with the ultimate goal of improving our lives.

The purpose of research is therefore to find out what is known, what is not and what we can develop further. In this way, scientists can develop new theories, ideas and products that shape our society and our everyday lives.

The purpose of research is to further understand the world and to learn how this knowledge can be applied to better everyday life. It is an integral part of problem solving.

[2] CHED CMO No. 25, series of 2015
[3] https://www.discoverphds.com/blog/what-is-research-purpose-of-research

Although research can take many forms, there are three main purposes of research:

Exploratory: Exploratory research is the first research to be conducted around a problem that has not yet been clearly defined. Exploration research therefore aims to gain a better understanding of the exact nature of the problem and not to provide a conclusive answer to the problem itself. This enables us to conduct more in-depth research later on.

Descriptive: Descriptive research expands knowledge of a research problem or phenomenon by describing it according to its characteristics and population. Descriptive research focuses on the 'how' and 'what', but not on the 'why'.

Explanatory: Explanatory research, also referred to as casual research, is conducted to determine how variables interact, i.e. to identify cause-and-effect relationships. Explanatory research deals with the 'why' of research questions and is therefore often based on experiments.

Characteristics of Research

There are 8 core characteristics that all research projects should have. These are:

Empirical – based on proven scientific methods derived from real-life observations and experiments.

Logical – follows sequential procedures based on valid principles.

Cyclic – research begins with a question and ends with a question, i.e. research should lead to a new line of questioning.

Controlled – vigorous measures put into place to keep all variables constant, except those under investigation.

Hypothesis-based – the research design generates data that sufficiently meets the research objectives and can prove or disprove the hypothesis. It makes the research study repeatable and gives credibility to the results.

Analytical – data is generated, recorded and analysed using proven techniques to ensure high accuracy and repeatability while minimising potential errors and anomalies.

Objective – sound judgement is used by the researcher to ensure that the research findings are valid.

Statistical treatment – statistical treatment is used to transform the available data into something more meaningful from which knowledge can be gained.

Types of Research

Research can be divided into two main types: basic research (also known as pure research) and applied research.

Basic Research

Basic research, also known as pure research, is an original investigation into the reasons behind a process, phenomenon or particular event. It focuses on generating knowledge around existing basic principles.

Basic research is generally considered 'non-commercial research' because it does not focus on solving practical problems, and has no immediate benefit or ways it can be applied.

For example, a researcher may try to investigate the molecular structure of a material for the purpose of understanding it's behaviour better as it is not yet well understood.

While basic research may not have direct applications, it usually provides new insights that can later be used in applied research.

Applied Research

Applied research investigates well-known theories and principles in order to enhance knowledge around a practical aim. Because of this, applied research focuses on solving real-life problems by deriving knowledge which has an immediate application.

For example, a person may undertake applied research to investigate whether they can modify the molecular structure of a material for the purpose of making it strong enough to be used in aircraft construction.

Methods of Research

Research methods for data collection fall into one of two categories: inductive methods or deductive methods.

Inductive research methods focus on the analysis of an observation and are usually associated with qualitative research. Deductive research methods focus on the verification of an observation and are typically associated with quantitative research.

Qualitative Research. Qualitative research is a method that enables non-numerical data collection through open-ended methods such as interviews, case studies and focus groups. It enables researchers to collect data on personal experiences, feelings or behaviours, as well as the reasons behind them. Because of this, qualitative research is often used in fields such as social science, psychology and philosophy and other areas where it is useful to know the connection between what has occurred and why it has occurred.

Quantitative Research. Quantitative research is a method that collects and analyses numerical data through statistical analysis. It allows us to quantify variables, uncover relationships, and make generalisations across a larger population. As a result, quantitative research is often used in the natural and physical sciences such as engineering, biology, chemistry, physics, computer science, finance, and medical research, etc.

What does Research Involve?

Research often follows a systematic approach known as a Scientific Method, which is carried out using an hourglass model.

A research project first starts with a problem statement, or rather, the research purpose for engaging in the study. This can take the form of the 'scope of the study' or 'aims and objectives' of your research topic.

Subsequently, a literature review is carried out and a hypothesis is formed. The researcher then creates a research methodology and collects the data.

The data is then analysed using various statistical methods and the null hypothesis is either accepted or rejected.

In both cases, the study and its conclusion are officially written up as a report or research paper, and the researcher may also recommend lines of further questioning. The report or research paper is then shared with the wider research community, and the cycle begins all over again.

Although these steps outline the overall research process, keep in mind that research projects are highly dynamic and are therefore considered an iterative process with continued refinements and not a series of fixed stages.

THE MEANING OF DESIGN[4,5]

In the area of engineering, design is the process of devising a system, component, or process to meet desired needs. It is a decision-making process (often iterative), in which the basic sciences, mathematics, and the engineering sciences are applied to convert resources optimally to meet fhese stated needs.

Thus, in the area of Computing or Information Technology Education (ITE), the term design includes, among others, (1) application development that focuses on software engineering processes or (2) application design that focuses on effective testing procedure or (3) a study on application development processes, in which basic sciences, mathematics and computing are applied to meet the stated needs.

The key word in design is the word "optimum." Good designs convert and/or uses IT resources optimally to meet the stated needs. It is for this reason why the Commission on Higher Education (CHED) defines the Bachelor of Science (BSIT) program as the study of the utilization of both hardware and software technologies in planning, installing, customizing, operating, managing, administering and maintaining IT infrastructure that provides computing solutions to address the needs of an organization. The same is true with the Bachelor of Science in Entertainment and Multimedia Computing (BSEMC). In the BS Information Systems (BSIS) program, the terminal step for design is when the system, particularly the information system, has been integrated and implemented in the business processes of an enterprise. Of course, the process will be iterative for the reason that design

[4] ABET, Criteria for Accrediting Engineering Programs (2015)
[5] Outcomes-Based Practical Guide to Thesis and Capstone Project Writing in Computing, Charlemagne G. Lavina, et al (2016)

no matter how carefully crafted and made is not perfect. Considering that the term "Research" and "Design" are two (2) different terms, the authors humbly submit that the term research is the applicable term for the Bachelor of Science in Computer Science (BSCS) program because the latter is a research-based program and hence, thesis is a requirement. The term design, on the other hand is the applicable term for the BSIT, BSIS and BSEMC programs because these programs require capstone projects.

Research and Design Distinguished

To research something is to investigate it systematically. We do this in order to reach new conclusions, establish new facts, and learn as much as about the truth as possible. Research also gives us a chance to find problems that we can potentially fix. We research to understand the world.

To design somethin is to create the form and function of an object, system or interaction. We do this in order to make our experience here on earth (or in space) better, safer, helthier, more comfortable, more fun – and we can create solutions to the problems we found during our research. We design to change the world.

Simply stated, we research to explain WHY THINGS happen; we design in order TO MAKE THINGS HAPPEN.

The Research Design vs Design Problem

A research problem is commonly defined as any significant, perplexing and challenging situation, real or artificial, the solution of which requires reflective thinking. A good research problem should be (1) **Specific**, (2) **Measurable**, (3) **Achievable**, (4) **Realistic**, and (5) **Time bound**.

Research	Design
It must be new	It does not need to be new
It does not have to be good	It has to be good
In sum, research does not have to be good but it must be new	In sum, design does not have to be new, but it must be good
It is done to understand the world	It is done to change the world

Let us assume that the following are the only sorting algorithms that exist, thus bubble sort, quick sort, insertion sort, and selection sort.

Suppose you were able to write a sorting algorithm, say, Hula Sort, which uses other means and methods other that the above-mentioned sorting algorithms; your algorithm shall be considered as new. Altogether, if the running time of such new algorithm is slower than any of the above algorithms, the same may be considered a research work because it is new. Hence, the best research output solves problems that are not only new but is worth solving; while the best design exceeds its predecessors (previous design) by using new or better ideas and/or methods.

Design and programming are human activities, forget that and all is lost.
- *B. Stroustrup*

BICOL UNIVERSITY RESEARCH CATEGORY[6]

Research Category: The research result under this category is based on experimental or theoretical work undertaken primarily to acquire new knowledge directed primarily towards a specific aim or objective.

Development Category: Output of systematic work, drawing on existing knowledge gained from research and/or practical experience that is directed towards producing new materials, product or devices, installing new processes, systems and services and improving substantially those already produced or installed.

BU Old Thematic Areas

Food Security and Poverty Reduction

Brief Description	Sample R&D Agenda
This strategic theme seeks to provide knowledge and evidence for policy development and to enable food producers and processors, retailers, consumers, and civil society to respond to and manage the challenges facing the food system comprising AFNR and fisheries sectors. It will integrate research in topics ranging from food production and processing to markets and distribution, consumption patterns, food safety dynamics, human nutrition and agricultural sustainability.	• Diversifying income sources by creating additional livelihood & employment opportunities in economically depressed areas • Expanding access of poor to productive assets via the sustainable use and enhanced quality of soil and water resources • Mitigating the impact of chemicals on human health and environment • Improving post-production and marketing efficiencies • Improving support services delivery to agriculture and fisheries sectors • Ensuring the effectiveness and efficiency of S&T interventions

Climate Change and Natural Resource Management

Brief Description	Sample R&D Agenda
This theme is a combination of two field of specialization with different point of views but agreed to a common conclusion – mismanagement of natural resource contributes to the vulnerability of human systems to climatic hazards, and enhanced management can provide a tool for community resilience and environmental sustainability.	• Assessment of vulnerability to climate change and development of response mechanisms • Rehabilitating and restoring priority ecosystems • Conserving, improving, valuing, and maximizing benefits of local genetic resources • Mitigation of different forms of pollutants in the environment • Formulation of good practices for climate change adaptation

[6] http://bicol-u.edu.ph/bu/research/home

Global Competitiveness of Business and Industry

Brief Description	Sample R&D Agenda
This theme is a respond to the Philippine Development Plan of being "Globally-competitive and innovative industry and services sector contributing to inclusive growth and employment generation" through (1) improved business environment, (2) increased productivity and efficiency, and (3) enhanced consumer welfare.	• Improving existing production systems and promoting optimal utilization of selected commodities • Improving supply chain of food products • Development of S&T-based agro and fisheries-based enterprises • Development of attractive regional investment climate

Social Development Promotion

Brief Description	Sample R&D Agenda
This theme focus on the development and improvement of the following specific areas of concerns: culture, health, education, gender, livelihood and governance.	• Access and equity in education • Effectiveness of education across levels • Relevance and quality of education • Efficiency in educational governance and management • Support improvement of the quality of health services • Protection, preservation, and promotion of Bikolano cultural heritage • Strengthening the culture and arts components at all levels of the educational system • Ensuring high-quality, efficient, transparent, accountable, financially and physically accessible and non-discriminatory delivery of public service • Curbing both bureaucratic and political corruption • Enhancing citizen's access to information and participation in governance

Institutional Policy

Brief Description	Sample R&D Agenda
This theme aims to provide research based feedback and assessment to the BU Administration on how to further improve the delivery of services and governance to its clientele and to its workforce.	• Improve University management of services • Improving basic social services

BU New Thematic Areas

Theme 1. Environment and Natural Resources Systems Management and Development

Brief Description	Sample R&D Agenda
This theme aims to determine and improve environmental issues that affect the land, air, and water in the region. It will apply the ridge to reef approach, valuation studies, biological remediation, and development of technologies for mitigation and waste utilization.	• Agendum 1: Improvement, rehabilitation and restoration of priority ecosystems • Agendum 2: Conservation, improvement, valuation and maximization of benefits of local genetic resources • Agendum 3: Ensuring sufficient and green energy • Agendum 4: Mitigation of different forms of pollutants in the environment • Others

Theme 2. Climate Change Adaptation and Disaster Risk Reduction

Brief Description	Sample R&D Agenda
This theme is about how we as a region should be able to mitigate and adapt to the "new normal" characterized by increased global temperature aggravated by anthropogenic activities affecting not only natural resource systems but also our current "way of life."	• Agendum 1: Assessment of vulnerability to climate change and development of response mechanisms • Agendum 2: Formulation of good practices for climate change adaptation • Agendum 3: Health DRRM and CCA • Agendum 4: Disaster Risk Management • Agendum 5: Policy and Governance for CCADRRM • Others

Theme 3. Socio-Economics, Culture and Arts, and Governance

Brief Description	Sample R&D Agenda
This theme focuses on the sociocultural richness of the Bicol region and its governance system. It includes but is not limited to the preservation of language, history, and culture, as well as the improvement of the economic participation of the rural populace and indigenous groups.	• Agendum 1: Protection, preservation, and promotion of Bikolano cultural heritage • Agendum 2: Strengthening the culture and arts components at all levels of the educational system • Agendum 3: Ensuring high-quality, efficient, transparent, accountable, and financially and physically accessible and non-discriminatory delivery of public service • Agendum 4: Curbing both bureaucratic and political corruption • Agendum 5: Enhancing citizen's access to information and participation in governance • Agendum 6: Institutional research • Agendum 7: Mental health and psychosocial intervention • Others

Theme 4. Health Systems Management and Development

Brief Description	Sample R&D Agenda
This theme is guided by the PCHRD and BCHRD thrusts and priorities on emerging and re-emerging health concerns and other international concerns. It aims to provide evidence-based solutions to pressing health problems brought by the changing lifestyle of the populace.	• Agendum 1: Support improvement of the quality of health services • Agendum 2: Improving health policy and governance • Agendum 3: Enhancing food safety • Agendum 4: Strengthening environmental health • Agendum 5: Intervention to address lifestyle related diseases • Agendum 7: Migration and health • Agendum 8: Models of rehabilitation • Agendum 9: Human resources for health • Agendum 10: Health information

Theme 5. Gender and Development (GAD)

Brief Description	Sample R&D Agenda
This theme is a response to CHED Memorandum Order No. 1, series of 2015, Philippine Commission on Women (PCW) Memorandum Circular No. 2018-04, and Bicol University Center for Gender and Development.	• Agendum 1: Gender-Responsive Governance and Political Participation • Agendum 2: Justice, Security, Peace, DRRM, and Gender • Agendum 3: Science and Technology Innovation for Gender Equality and Women Empowerment • Agendum 4: Changing Norms and Culture for Gender Equality and Women Empowerment • Agendum 5: Violence-free Society • Agendum 6: Women and Health • Agendum 7: Improve GAD capability building • Agendum 8: Inclusion of GAD on Instruction, Research, and Extension • Agendum 9: GAD Information Dissemination, Advocacies, and Data Generation • Agendum 10: GAD Policy Initiatives/Change • Agendum 11: Matching Mismatches: Tracking of Women

Theme 6. Inclusive Education and Lifelong Learning

Brief Description	Sample R&D Agenda
This theme is both a driver and a response for improving the educational system in the region as it measures the access, relevance, and effectiveness educational governance.	• Agendum 1: Access and equity in education • Agendum 2: Effectiveness of education across all levels • Agendum 3: Relevance and quality of education • Agendum 4: Efficiency in educational governance and management • Agendum 5: Global citizenship education • Agendum 6: Pedagogy and perspectives in learning and teaching

Theme 7. Food & Nutrition Security and Poverty Reduction

Brief Description	Sample R&D Agenda
This strategic theme seeks to provide knowledge and evidence for policy development and to enable food producers and processors, retailers, consumers, and civil society to respond to and manage the challenges facing the food system comprising AFNR and fisheries sectors. It will integrate research in topics ranging from food production and processing to markets and distribution, consumption patterns, food safety dynamics, human nutrition, and agricultural sustainability. A key aspect will be adding value to current and future research, through greater coordination to improve the design, delivery, and translation of research across many disciplines comprising agriculture, fisheries, and natural resources.	• Agendum 1: Securing the sources of productivity growth in the AFNR and fisheries sectors • Agendum 2: Diversifying income sources by creating additional livelihood and employment opportunities in economically depressed areas • Agendum 3: Expanding access of poor to productive assets via the sustainable use and enhanced quality of soil and water resources • Agendum 4: Mitigating the impact of chemicals on human health and environment • Agendum 5: Improving post-production and marketing efficiencies • Agendum 6: Improving support services delivery to the agriculture and fisheries sectors • Agendum 7: Ensuring the effectiveness and efficiency of S&T intervention

Theme 8. Scientific, Technological Innovations and techno-entrepreneurship in Industry, Energy, Emerging Technologies for Global Competitiveness

Brief Description	Sample R&D Agenda
This theme is a response to the global market's increase in sophistication and consumers' increasing demand for innovative products and services. This aims to grow the sophistication of businesses and industries, as well as improve quality standards to ensure that acceptable products will be available to domestic and international consumers. It further aims to increase the use of renewable energy for the regions, making it more affordable and sustainable. The theme will intensify the culture of competitiveness, focus interventions in key industry areas, enhance firm level support to MSMEs, expand industry cluster development, increase market access, and improve the supply chains of basic and prime commodities.	• Agendum 1: Improving existing production systems and promoting optimal utilization of selected commodities • Agendum 2: Improving supply the chain of food products • Agendum 3: Development of S&T-based agro and fisheries-based enterprises • Agendum 4: Enhancing indigenous/renewable energy source, as well as energy source conservation and efficiency

WHAT IS A CONCEPT PAPER?[7]

A concept paper is a short document written by a researcher before starting their research project, with the purpose of explaining what the study is about, why it is important and the methods that will be used.

The concept paper will include your proposed research title, a brief introduction to the subject, the aim of the study, the research questions you intend to answer, the type of data you will collect and how you will collect it. A concept paper can also be referred to as a research proposal.

What is the Purpose of a Concept Paper?

The primary aim of a research concept paper is to convince the reader that the proposed research project is worth doing. This means that the reader should first agree that the research study is novel and interesting. They should be convinced that there is a need for this research and that the research aims and questions are appropriate.

Finally, they should be satisfied that the methods for data collection proposed are feasible, are likely to work and can be performed within the specific time period allocated for this project.

How Long is a Concept Paper?

The concept paper format is usually between 2 and 3 pages in length for students writing proposals for undergraduate.

How do you Write a Concept Paper?

There are 6 important aspects to consider when writing a concept paper or research proposal:

1. The wording of the title page, which is best presented as a question for this type of document. At this study concept stage, you can write the title a bit catchier.

2. A brief introduction and review of relevant existing literature published within the subject area and identification of where the gaps in knowledge are. This last bit is particularly important as it guides you in defining the statement of the problem. The concept paper should provide a succinct summary of 'the problem', which is usually related to what is unknown or poorly understood about your research topic. By the end of the concept paper, the reader should be clear on how your research idea will provide a 'solution' to this problem.

3. The overarching research aim of your proposed study and the objectives and/or questions you will address to achieve this aim. Align all of these with the problem statement; i.e. write each research question as a clear response to addressing the limitations and gaps identified from previous literature.

[7] https://www.discoverphds.com/blog/concept-paper

4. The specific data outputs that you plan to capture. For example, will this be qualitative or quantitative data? Do you plan to capture data at specific time points or at other defined intervals? Do you need to repeat data capture to asses any repeatability and reproducibility questions?

5. The research methodology you will use to capture this data, including any specific measurement or analysis equipment and software you will use, and a consideration of statistical tests to help interpret the data. If your research requires the use of questionnaires, how will these be prepared and validated? In what sort of time frame would you plan to collect this data?

6. Finally, include a statement of the significance of the study, explaining why your research is important and impactful. This can be in the form of a concluding paragraph that reiterate the statement of the problem, clarifies how your research will address this and explains who will benefit from your research and how.

Key Point: Ensure your research question aligns with the problem statement you defined.

You may need to include a short summary of the timeline for completing the research project. Defining milestones of the time points at which you intend to complete certain tasks can help to show that you've considered the practicalities of running this study. It also shows that what you have proposed is feasible in order to achieve your research goal.

Make sure to include references and cite all other literature and previous research that you discuss in your concept paper.

See **Appendix B** for Sample of Concept Paper.

BUPC UNDERGRADUATE THESIS FORMAT GUIDELINES AY 2020-2021

Composition of Capstone Project

- 3 members/students per group
- 1 qualified faculty/adviser per group

Choosing your Adviser

The adviser must come preferably from the faculty of the Computer Studies Department (CSD) where the student belongs and must be chosen according to the following criteria:

PROGRAM: Experience in the Research area/field of specialization

RAPPORT: Must have established good rapport with advisee

TIME: Must have enough time for advising

Qualification of the Adviser

A research adviser should be deemed qualified if he/she is:

- A researcher recognized by the institution, masters/doctoral degree holder, researcher of his/her own study and participant to previous research trainings and seminars sponsored by CHED and the University/College;
- A full-time faculty member undergoing research within his/her specialization.

See **Appendix C** for BUPC Undergraduate Thesis Format Guidelines AY 2020-2021; **Appendix D** for Work Instruction for Student Researches; **Appendix E** for Sample of Adviser's Acceptance Letter/Acceptance Form and Sample of Application for Working Title.

PERFORMANCE TASK 1

Prepare and submit Concept Paper.

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_____
_____
_____.

STUDY GUIDE

2 WRITING THE COMPONENTS OF CHAPTER 1

INTENDED LEARNING OUTCOMES

At the end of this lesson, the student is expected to:

- Differentiate thesis against a capstone project;
- Be familiar with the different topics from which a good research problem and/or design may be derived;
- Have a general overview on how to do a thesis and/or capstone project;
- Create a list of possible research or capstone project topics;
- List all necessary components of Chapter 1 of a thesis and/or capstone project;
- Write a good introduction/project context/background of the problem;
- Formulate the statement of the problem and/or objectives of the study;
- Demonstrate the significance of the study or the purpose and description of the study/project;
- Explain and justify the limitations of the study; and
- Write a good Chapter 1 of a thesis and/or capstone project.

Degree Program Requirements

This section deals with the specific requirements mandated by the Commission on Higher Education (CHED) for the different computing programs such as the Bachelor of Science in Computer Science (BSCS) program; the Bachelor of Science in Information Technology (BSIT) program; the Bachelor of Science in Information Systems (BSIS) program and the Bachelor of Science in Entertainment and Multimedia Computing (BSEMC) program.

In the BSCS program, which is a research-based program, thesis is a requirement. Here, contents must be focused on the theories and concepts of computing and it should be in the form of scientific work, which may be presented in a public forum. For the BSIT, BSEMC and BSIS programs, the requirement is a capstone project in the form of a systems application for BSIT or an enterprise resource plan for BSIS program (CMO 53 s. 2006).

Both thesis and capstone project are considered courses that require a culminating activity that generates an output useful in the development of solutions. Thesis is research activity while capstone project involves design.

What is a Thesis?

A thesis may be defined as the report of a scholar upon some piece of research which he has completed. It is the culmination of a devious process extending from the initial insight into the opportunity for investigation to the insertion of the final footnote (Cole and Bigelow, 1935). In the area of computing, it is defined as a technical report on a systematic investigation of a problem that can be solved using Computing. It may include a solution, an approximate or partial solution, a scientific investigation, or the development of results leading to the solution of the problem (Section 2.1, Article II of Annex A of CMO 25 s. 2015).

What is a Capstone Project?

A Capstone Project is an undertaking appropriate to a professional field. It should significantly address an existing problem or need. An Information Systems (IS) Capstone Project focuses on business processes and the implications of introducing a computing solution to a problem while an Information Technology (IT) Capstone Project focuses on the infrastructure, application, or processes involved in implementing Computing solution to a problem (Section 2.2, Article II of Annex A of CMO 25 s. 2015). Of course, for the BSEMC program the capstone project deals with game development and digital animation Technology (Section 8.2.3 of CMO 2 series of 2014)

Under OBE parlance, a capstone project is the design completed by a student, which results in an optimum use of the resources demonstrating his competencies gained from his educational experiences.

The authors subscribe to the recommendation of the Philippine Society of Information Technology Educators (PSITE) and Computing Society of the Philippines (CSP) in choosing topics (but not limited to) for each program area which is similar to the sample Thesis / Capstone guidelines issued by CHED contained in Annex A of CMO 25 series of 2015.

Computer Science

Current Computer Science Topics

- Software and Development Theory
- Mobile Computing Systems
- Software Extensions or Plug-ins
- Expert Systems and Decision Support Systems

- Systems Software (software tools/utilities, interpreters, simulators, compilers, security aspects
- Intelligent Systems
- Game Development
- Computer Vision
- Image / Signal Processing
- Natural Language Processing
- Pattern recognition and data mining
- Bioinformatics
- Graphics Applications
- Cloud Computing
- Parallel computing
- Embedded systems
- Emerging Technologies

Foundations of Computer Science

- Automata and Formal Languages
- Data Structures and Algorithm Design and Analysis
- Web Semantics
- Coding theory
- Programming languages
- Visualization systems
- Computer and Architecture
- Modeling and Simulation
- Grid Computing
- Pervasive Computing

Human-Computer Interaction

- Usability
- Affective Computing
- Emphatic Computing

Information Technology

Software Development

- Software Customization
- Information Systems Development for an Actual Client (with pilot testing)
- Web Applications Development (with at least alpha testing on live servers)
- Mobile Computing Systems

Multimedia Systems

- Game Development
- e-Learning Systems
- Interactive Systems
- Information Kiosks

Network Design and Implementation and Server Farm Configuration and Management

IT Management

- IT Strategic Plan for sufficiently complex enterprises
- IT Security Analysis, Planning and Implementation

Information Systems

Software Development

- Software Customization
- Information Systems Development for an Actual Client
- Web Applications Development
- Mobile Computing Systems

IS Planning

- Enterprise Resource Plan
- Information Systems Strategic Plan

Analysis and Design of a sufficiently complex business system

BS EMC Topics

In 2014, CHED issued CMO 02, series of 2014, "Policies, Standards and Guidelines for Bachelor of Science in Entertainment and Multimedia Computing (BS EMC) Program." This program is similar to the BSIT program but focuses on Game Development and Digital Animation Technology.

The following are the sample thesis and capstone project format based on Annex A of CMO 25 series of 2015. The authors would like to emphasize that there is NO single correct thesis template or format. The school, in the exercise of its academic freedom, may use other format(s).

CHED's Suggested Documentation Template/Format[8]

CS Thesis (Foundations of Computer Science)	CS Thesis (Software Development)	IT / IS Capstone Project
Title Page Abstract Table of Contents List of Figures, List of Tables, List of Notations	Title Page Abstract or Executive Summary Table of Contents List of Figures, List of Tables, List of Notations	Title Page Executive Summary Table of Contents List of Figures, List of Tables, List of Notations]

[8] Draft Annex A of the Revised Policies and Standards for BSCS, BSIS and BSIT Programs Aligned to OBE

Introduction Background of the Problem Statement of the Problem Objectives of the Study Significance Scope and Limitations	Introduction Project Context Purpose and Description Objectives Scope and limitations	Introduction Project Context Purpose and Description Objectives Scope and limitations
Related Literatures Theoretical Background	Related Literatures Technical Background	Review of Related Literature / Systems -Technical Background
Proposed Solution to the Problem	Design and Methodology	Methodology, Results and Discussion Requirement Analysis Requirements Documentation Design of Software, Systems, Product and/or Processes Development and Testing, where applicable Description of the Prototype, where applicable Implementation Plan (Infastructure / Deployment) where needed Implementation results, where Applicable
Results and Discussion	Results and Discussion	
Conclusions and Recommendation	Conclusions and Recommendation	Recommendations
Appendices	Appendices	Appendices

Irrespective of the format you will be using, this book will guide you how to effectively write each of the components of your thesis or capstone project. Thus, it will be mandatory for this textbook to discuss every component of the thesis or capstone project included in the above template provided by CHED's Technical Panel for IT Education. In addition thereto, this text will also discuss some thesis / capstone project components which were not included in the above template such

as theoretical framework, conceptual framework, synthesis, among others. These thesis / capstone project components may be adopted by schools and universities in the exercise of its academic freedom. Moreover, the book will provide discussion on the distinguishing characteristics of the components of thesis and capstone project, such as:

- the statement of the problem of a computer science thesis and objectives of the project of a capstone project;
- Significance of the study of a computer science thesis and purpose and description of a capstone project, among others;

Writing a Good Introduction

In formulating these guidelines, the authors used as reference the works of Calmorin and Calmorin (1995) as well as the works of Sevilla, Ochave, Punzalan, and Uriarte (1984) and made the necessary modifications and amendments so that it will be fitted for computing students.

Guidelines in writing the introduction. A good introduction of an IT and IS capstone projects should contain a discussion of all of the following:

1. **Presentation of the importance of the system software, algorithms, processes or an enterprise resource plan to be designed and/or developed.** This must be the start of an introduction. In a capstone project entitled: **"DEVELOPMENT AND EVALUATION OF A DECISION SUPPORT SYSTEM FOR THE JIL CHURCH – CALAMBA CITY USING TRANSACTION PROCESSING AS PERCEIVED BY ITS ADMINISTRATORS AND WORKERS FOR THE YEAR 2015"** the main objective of which is a development of an Information System(IS) and/or a Decision Support System (DSS), part of the introduction reads in part:[9]

Organizations have long recognized the importance of managing key resources such as labor and raw materials. Information has now moved to its rightful place as a key resource. Decision makers are beginning to understand that information is not just a by-product of conducting business, rather, it fuels business and can be the critical factor in determining the success or failure of a business.

To maximize the usefulness of information, a business must manage it correctly, just as it manages other resources. Managers need to understand that costs are associated with the production, distribution, security, storage, and retrieval of information. The strategic use of information for positioning a business competitively should not be taken for granted.[10]

[9] In this book, whenever you see the sign Demo, it means example or demonstration.
[10] Kenneth Kendall and Julie Kendall, Systems Analysis and Design (Singapore:Prentice Hall,1997)

The above title is a sample IT or IS Capstone project and strictly speaking is not for the BSCS program. Of course, the Dean, in the exercise of his discretion, may accept as thesis, a project which should be considered as a capstone project only, considering the difficulty of the thesis requirement of the BSCS program.

2. **Research Locale**. Tell something about the organization or group where the research will be conducted. This organization usually is the target beneficiary of the proposed system software. In the sample capstone project, the organization under study is the JIL Church at Calamba City.

   This part may NOT applicable for a BSCS thesis. Instead of research locale "A Description of the Area in Computer Science under Study" shall be discussed in Computer Science theses.

Example[11]:

It was on June 15, 1986 when the first worship service of the Jesus Is Lord Fellowship Calamba Chapter, now Jesus Is Lord Church Calamba Chapter was held with hundreds of attendees, guests and visitors and even pastors from other Evangelical churches. But its second worship service revealed the actual number of attendees consisting of only fifty (50) estimated attendees, a resident pastor and three volunteered workers.

During the JIL's first few years of operation, information managing is not a problem. Almost all of its attendees know each other and the resident pastor can easily recognized and call them by their names. Thus, if one attendee was not able to attend Sunday services for several times, the Follow-up Ministry can easily recognized them and make an appropriate decision and action like house visitation to discern the reasons why their breathren was unable to attend their worship service. This will enable the Follow-up Ministry to make a sound biblical advice.

3. **The existence of an unsatisfactory condition; a felt problem that needs a solution. A solution that involves development of a system software.**

Example:

At present, this situation does not hold true anymore. The JIL Church now has an average of one thousand attendees per week. Sometimes, during special worship service, the total number of attendees reached one thousand five hundred at the most. And sadly, because of poor information management, the leadership was unable to produce the list of additional five hundred attendees. This made the Follow-up Ministry helpless in achieving the JIL Calamba's Vision of "Harvest 3000 plus souls." Additionally, a regular attendee who was absent during the last two to three weeks was hardly noticed. Only those popular attendees can be

[11] Our sample thesis example is using a single space format in order to save space to minimize the cost of this book.

recognized absent and consequently they are the only members of the Church who are being followed up or being taken care of. Decision making, consequently is done under uncertainty.

4. **A desire to find a better way of doing something or improving the present system.**

Example:

It is for this reason why, the proponent, being a member of the JIL Church, gains a deepest desire to find a better way of improving the present condition by developing a software called as "Church's Decision Support System" (CDSS), that will help solve the unsatisfactory monitoring of the attendance of JIL Church members.

If all the elements of a good introduction are present so that in the end, it will be able to convince the reader or a person who shall be benefitted by the proposed project that there is really a need in doing the same, then, such introduction had set the ***Project Context*** of a capstone project. Bear in mind that the "project context" forms part of the **Introduction**.

The project context is the environment in which a project is undertaken. It has two key perspectives: internal as defined by the organizational structure, management, behaviour and culture external as defined by the business environment in which the organization operates, including legislation and regulation, professional and industrial standards, and market sectors. Project sponsors and managers need to understand both the internal and external factors that can affect their projects. This topic explains the environmental factors that affect projects. It describes approaches for analyzing internal and external factors and managing stakeholders.[12] This is the reason why "project context" is not included in thesis involving foundations of Computer Science.

The above introduction except for No.2, is also applicable for a BSCS research.[13] Instead of focusing on the research locale, the researcher should provide a background on the area of computer science involved in his research.

Suppose we have a computer science thesis entitled:

Battleship: An Artificial Intelligence for Battleship Game using Genetic Algorithm[14]

[12] Project Training Solutions Ltd. (2008). Project Context, Retrieved March 5, 2015 from http://www.openpm.co.uk/OpenPM/Shared/APM/Readers/Module1/106R%20Project%20Context%20v%201.02.pdf

[13] In Computer Science thesis dealing with foundation in computer science, this is equivalent to Background of the Problem.

[14] Alexader A. Hernandez, Enrico P. Chavez and Praxedis S. Marquez (NCITE:2012).

The following is a good introduction.

1. **Presentation of the importance of the software to be developed**. This must be the start of an introduction. Here the software to be developed is Artificial Intelligence (AI).

   Today, advanced technology is trying to master the creation of the brain related to the world of Artificial Intelligence. Artificial intelligence is the ability of machines to do things that people would say require intelligence. Artificial Intelligence aims to improve machine behavior in tackling such complex tasks. Together with this, much of the AI research is allowing us to understand our intelligent behavior.

   There are many different approaches to Artificial Intelligence and none of which are either completely right or wrong. Over the years, trends have emerged based on the state of mind of influential researchers, funding opportunities as well as available computer hardware.

2. **A Description of the Area in Computer Science under Study**. In our sample thesis, the area in computer science under study is AI.

   AI research is an attempt to discover the describe aspects of human intelligence that can be simulated by machines. A good example, play games of strategy and learn to play better than people. Gaming is one genre of software programming that has been slowly borrowing more and more from the field of Artificial Intelligence.

   Game playing has remained a valuable subfield of AI research with the potential of shedding light on and testing AI results in other domain. And games will remain a challenge to AI researchers, providing a domain in which efforts can be focused on expert systems, knowledge representation, and learning.

3. **A statement indicating that an improvement can be done.**

   Nowadays, Games are no longer just a distraction from studies or work. They are becoming an artistic form of expression for the programmers and developers and a serious hobby and undertaking for the players.

   Games are learning devices, and the fundamental quality of good learning is one which is appropriately demanding and manageable. Games are exploring the capabilities of artificial intelligence. The rules are fixed, the scope of the problem is constrained, and the interactions of the players are well defined.

4. **A desire to find a better way of doing something or improving the present system.**

   The aim of game Artificial Intelligence is not to provide a lasting challenge, but to provide a smoothly ramping level of difficulty, while the player is learning to think either strategically, tactically, or reactively. Artificial intelligence in games takes the role of a never-bored and never-boring opponent.

Formulating the Statement of the Problem[15] / Objectives of the Project

There should be a general statement of the whole problem followed by the specific questions or sub-problems into which the general problem is broken up.

Guidelines in formulating the general problem and specific questions:

1. The general statement of the problem and the specific questions should be formulated first before developing the software programs.
2. Each specific question must be clear and unambiguous.
3. Answers to specific questions must contribute to the development of the whole research problem or capstone project.
4. The number of specific questions should be enough to cover the whole problem or case under study.
5. Generally, there should be a general statement of the problem and then broken up into as many specific questions as necessary.

Sample Illustration:

To illustrate, let us provide a sample Statement of the Problem for an IT capstone project, thus:

The main problem of the project is to assist the Tabako University in the admission, registration, monitoring and advising of their students. Specifically it attempted to answer the following questions:

1. How to design and develop a Web-based system called Admission Registration and Monitoring System (ARMIS) which will be capable of:
   a. providing and efficient on-line enrollment system wherein payment may be made in campus and out campus;
   b. providing an advising system by generating appropriate courses which should be registered by the students considering the pre-requisites and co-requisites of courses provided in the student's program of study;
   c. allowing faculty members to encode the grades during a period to be determined by the use;
   xxx
   xxx
   xxx

[15] Statement of the problem is for a CS thesis involving Foundations of Computer Science.

2. What is the level of conformity of the ARMIS software with regard to the IS0 9126 standards?

3. How to implement and deploy the ARMIS software in order to maximize organizational benefits?

In correctly observing the above examples, problem statements do not refer to the problems being experienced by the organization under study nor the gaps in the theoretical aspects of computing. Rather, the statement of the problems refers to the challenges, goals or objectives which are needed to be accomplished by the proponents. It has been observed that one of the common errors manifested in some capstone projects of computing students is that under the "Statement of the Problems", they put herein those unsatisfactory conditions that needs solutions. These unsatisfactory conditions should be mentioned under introduction coughed in general terms and discussed in details under the "project context" under Chapter 1.

Objectives of the Study[16]

The objectives of the study guide the researcher and the reader to know what the proponent(s) need to do. These usually follow the chronological sequence of the statement of the problem and its specific questions.

Objectives are written by either beginning with an action verb or an infinitive.

For example:

- to determine the efficiency of the system as perceived by the employees; or
- identify possible problems encountered with the present system.

Example:

The main objective of the project is to assist the Tabako University in the admission, registration, monitoring and advising of their students. Specifically it aims to:

1. Design and develop a Web-based system called Admission Registration and Monitoring System (ARMIS) which will be capable of:
   a. providing and efficient on-line enrollment system wherein payment may be made in campus and out campus;

[16] This is usually applied in technical research instead of statement of the problem

b. providing an advising system by generating appropriate courses which should be registered by the students considering the pre-requisites and co-requisites of courses provided in the student's program of study;

c. allowing faculty members to encode the grades during a period to be determined by the use;

xxx
xxx
xxx

2. Evaluate the ARMIS in order to determine if it complies with the IS0 9126 standards;

3. To prepare an implementation plan for the deployment of the ARMIS.

xxx
xxx
xxx

Notice that the Objectives of the Study is the same as the Statement of the Problem. The only difference is that the latter is written in an interrogative form while the former is in the declarative form.[17] Thus, a researcher may use either one of the two. In technical research like Computing, CHED's template strongly suggested that we use Objectives of the Study instead of Statement of the Problem for all IT/IS capstone project and Computer Science theses dealing software development. Statement of the problem shall be used only for theses in computer science dealing with foundations and mathematical aspects of computer science.

Normally, there are usually three to five objectives of the study.

Sample objectives for our Computer Science thesis involving Artificial Intelligence and Genetic algorithms are the following:

General Objective:

This study aims to develop a game application that uses genetic algorithm for the games' artificial intelligence that can compete with the abilities of the human.

Specific Objectives:

The following statements are the specific objectives of the study:

1. To implement the Battleship board game in mobile phone supported with Google's Android platform.

[17] Laurentina Calmorin and Melchor Calmorin, Methods of Research and Thesis Writing. (Manila:Rex Book Store,1995).

2. To develop Artificial Intelligence for Battleship game with easy and difficult level.
3. To use Genetic Algorithms in developing the game's Artificial Intelligence.

At any rate, in objectives and statement of the problems, the totally of each objective/problem statement should contribute to the development of the software to be developed and/or formulation or improvement of mathematical models, algorithms and computer science theories as the case may be.

In the research entitled "The Mythical Adventures of Mang Kanor: An Action-Adventure Game"[18], the general and specific objectives of the study are presented in this wise:

General Objective

The general objective of the study is to develop an action adventure game, and familiarize the players about the mythical creatures believed exist in Visayas region. According to an article written by Miguel Almario of Clarksville Middle School and Micha F. Lindemans said that there are isolated islands and barrios in Visayas familiar about the different way of living and secrets of these mythical creatures.

Specific Objectives

- *Introduce the story of the mythical creatures here in the Philippines through game development;*
- *Integrate appropriate algorithms to be applied in the game, and*
- *Evaluate the game in terms of its functionality, usability, reliability, efficiency."*

Statement of the Problems vs. Objectives of the Project

The authors have spent too much time thinking about and in fact have browsed different researches in computing to see how the two terms are being used. The authors are privileged to be members of panel of examiners of different colleges and universities. They noticed that either statement of the problems or objectives of the project is required in any thesis and/or capstone project. In some schools' thesis / capstone project format, both are required. Unfortunately, the only difference between the statement of the problems and objectives is that the former is written in interrogative form while the latter is written in declarative form. It is our humble opinion that such is redundant. This should not be the case.

Question: Is it absolutely wrong to include both the statement of the problem and objectives of the project/study?

Answer: Not really.

[18] Reynaldo E. Castillo, Mark Allen Q. Domagas, Paul M. Grafilon and Roniel N. Pagaling, (NCITE: 2014)

While it is true that one of the differences of the Statement of the Problems and Objectives of the Project is that the former is written in interrogative form while the latter is written in declarative form, this difference is not the determining factor in choosing what to use between the two.

Please bear in mind that in purely computer science thesis, both statement of the problems and objectives are required.[19] In any other cases, only objective of the study/project is required. Why is this so?

The real and the substantive difference between the significance of the study and objectives of the study/project will reveal the answer.

In purely computing thesis, the researcher(s) need to reach new conclusions, establish new facts, and learn as much about the truth possible. Again, we will say it again, "we research to understand the world" or to explain "why things happen."

In layman's terms, if we want to know if Pedro is in his house in Cabuyao, the answer could be positive or negative. The question, "Is he (Pedro) in the house?" is a researchable problem because we are not sure what will be the answer to this question. In this case, "statement of the problem" should be used. Now, if we are certain already that Pedro is in the house and we want to command him to clean the house, we are certain what will be the outcome of our purpose, that is, the house will be dirt free or less dirty at the very least . In this case, the "objectives of the project" should be use. It is also for this reason why in a software development, conclusions is not required because in software development, the proponent begins with the end in mind, the end in mind refers to the requirement documentation.[20] So, there is no need to conclude because the proponent is already aware of the final outcome of his design because that is his objective or goal. Remember, we design to "make things happen" so we should NOT conclude and explain "why things happen in a capstone project."

The Significance of the Study and the Purpose and Description

At the outset, the students should be made aware that in CHED's suggested template for thesis / capstone project, significance of the study is only included in computer science theses concerning foundations of computer science. Other topics in computer science as well as those of capstone projects require purpose and description.

Significance of the Study[21]

The statement of significance is an important part of a scientific report particularly in computer science theses involving foundations of Computer Science. All scientific studies should be significant in one way or another, because

[19] Please refer to the CHED's suggested template for CS thesis involving purely computer science topics.
[20] Requirement Documentation will be discussed under Chapter IV of this book.
[21] A Center of Excellence school in Manila termed this as "Impact on Current Operation" in Capstone Project.

as mentioned in Chapter 1, it is intended to add to the body of knowledge. The significance of the study therefore will assert and explain to the reader why the study is vital and essential. Simply stated, this part of the thesis will provide the contribution of your study to the field of computing science. In other countries, this part of the thesis is termed as "Contributions."

Dr. Manjunath Narayana, in his Computer Science thesis entitled PROBABILISTIC MODELS FOR MOTION SEGMENTATION IN IMAGE SEQUENCES, explain the contribution or significance of his study in this wise:[22]

Contributions of the Thesis

The main contributions of the include:

1. *Description of a probabilistic background model that intuitively combines location-specific priors and spatially smoothed appearance likelihoods for the background and foreground.*
2. *Improvements to stationary camera motion segmentation algorithms by using pixel-wise adaptive kernel variances resulting in the state of the art accuracy on benchmark data.*
3. *Development of an accurate moving camera motion segmentation algorithm that addresses current challenges in segmentation by using optical flow orientations in a non-parametric probabilistic model.*
4. *Introduction of a rotation compensation algorithm that enables the application of the segmentation algorithm to videos that contain both translation and rotation motion of the camera.*

Purpose and Description

The purpose and description as part of the outline for Capstone Project as well as that of a computer science thesis involving software development is similar but not identical to Significance of the Study of a Computer Science thesis involving foundations of Computer Science. In writing purpose and description, the proponent must state the function of his capstone project. It should not attempt to claim that the project will add to the body of knowledge. It is for this reason that the authors humbly submit, that members of the panel of examiners should not ask the proponent(s) the following question:

"What is the contribution of your capstone project to the body of knowledge?"

[22] Manjunath Narayana, Probabilistic Models For Motion Segmentation In Image Sequences (University of Massachusetts – Amherst,2014)

This is because IT and IS capstone projects, generally, do not contribute to the body of knowledge but focuses on the contribution of the project to its specific beneficiaries.

Hence, the importance of the capstone project must contain explanations or discussions of any or all of the following:

1. The rationale, timeliness and relevance of the study.
2. Possible solutions to existing problems or improvement to unsatisfactory conditions.
3. The beneficiaries, and how they are going to be benefited.
4. Possible contribution to the fund of knowledge (if any).
5. Possible implications.

It is good to start the purpose and description by providing the function of the capstone project, thus:

In the capstone project entitled, "Development and Evaluation of Classroom Schedule Generator (CSG): An Expert System Using Microsoft Visual Basic"[23] the Purpose and Description was written as follows:

Purpose and Description

The project was conducted in order to assist the school administrators in the preparation of classroom schedules as well as teaching loads of faculty members every term or semester by developing a software called Classroom Schedule Generator (CSG). Once developed, CSG shall automatically prepare the classroom schedules of students and teaching loads of faculty members."

After providing its function, the second paragraph should provide description of the project by enumerating its features and capabilities. The following paragraph is a good illustration, thus:

CDS, an expert system have the following capabilities:

1. *Assign classes, lecture or laboratory, in appropriate rooms. Hence, lecture classes shall not be assigned to laboratory classrooms and laboratory classes shall not be assigned to lecture classes.*
2. *Maximizes room, student and faculty schedules depending on the priority set by the users. Hence, if there is a shortage of faculty member, say, only one teacher can handle a particular course, then the highest priority shall be set to faculty. On the other hand, if there is only one computer laboratory room, the highest priority shall be set to the said laboratory room.*
3. *Assigned teaching load of faculty members in accordance to the course and time schedule preference set by the users. So, in case of part time faculty members, is*

[23] Charlemagne G. Lavina, Development and Evaluation of Classroom Schedule Generator (CSG): An Expert System Using Microsoft Visual Basic (Manila:TIP Research Journal,2007)

only available T-TH 5.00-9:00PM, the system cannot assign classes to him beyond the said schedule;

4. *Ensure that only four(4) preparations shall be given to any faculty members;*
5. *Provide full load for fulltime faculty members depending on the number of units set by the user. So, if fulltime faculty members is teaching 18 units, 18 units shall be set; if the teaching units is set beyond 18 units, it means that the dean is allowing the said faculty members to have overload.*
7. *Make an appropriate recommendation in case there will be not enough resources in making schedules.*

In writing the "**Purpose and Description**", the features and capabilities should be written in such a way that it would highlight the significance of the project. Furthermore, it should be written using a general language and non-technical terms. This is to distinguish it from "**Requirement Documentation**"[24] which states what the software will do in greater details. Requirement Documentation will be discussed under Chapter IV of this book.

After enumerating the project's features and capabilities, the last paragraph should explain project's rationale, timeliness and relevance by illustrating that it will solve existing problems. Possible beneficiaries as well as implications may also be given. Our next example involving an IT Capstone Project entitled *Acceptability of the Multipurpose Community Information and Telecenter (MCIT) prototype towards E-Governance and Bridging the Digital Divide*[25] provides a good example of how the specific beneficiaries will be benefitted by the project.

Purpose and Description

Information and Communications Technology (ICT) usage particularly the Internet has become a valuable resource throughout the country. Its use has forever changed the way people communicate, do business and are educated. Physical distances between people have been narrowed as the Internet has made it possible to reach people almost instantly. At the same time, grave inequities exist in terms of who actually has access to Internet services. This discrepancy in access is called the Digital Divide. Data shows that the Internet and computer technologies are available far more to wealthy and educated people than they are to the poor and to racial minorities. The purpose of the project to bridge the so called digital divide.

[24] Requirement and Documentation is under Methodology and Design
[25] Charlemagne G. Lavina (Letran Calamba Graduate School:2006)

Once the proposed MCIT, which promotes the use of ICT, is implemented to every barangay in the Philippines, it will give the following national significance particularly to the following:

1. ***National Economy.*** *The Digital Divide is an essential issue to be addressed by the study because not all citizens are able to enjoy the benefits that come from ICT usage particularly the Internet. The Internet is an important resource that has grown because of its universality, yet there are millions of people who simply cannot access the new technology because of its cost. The Internet, then, is an essential good because of the role it plays in communication and commerce worldwide. However, if the Internet remains an unattainable good to citizens of lower socioeconomic status, it could intensify current social divisions, resulting in wider economic inequities. Establishing Community Telecenters to every barangay which typically provide public access to computers, the Internet, and other communication technologies, is the first step towards bridging the digital divide.*
2. ***Commission on Election (COMELEC).*** *During every election, registration and validation of every citizen of the country shall no longer be needed. The Commission on Elections (COMELEC), after an appropriate process, can retrieve the records of every citizen for each barangay. In addition, double registration is not possible in an MCIT enabled barangays. This is because the MCIT prototype uses biometrics technology particularly the fingerprint of an individual as key for identification. Henceforth, the integrated system can easily detect multiple fingerprints in different barangays.*
3. ***National Statistics Office (NSO).*** *The regular census conducted by the National Statistics Office for each barangay in the whole country shall be minimized. This is because MCIT barangays have updated records and therefore, the NSO can retrieve the database instead of doing a costly census usually conducted by inexperienced workers. The amount of money that shall be saved by the NSO and COMELEC when MCIT system is implemented for each barangay in the country cannot be discounted.*
4. ***Local Government Units (LGUs).*** *With the proposed MCIT system, Chapter 5, Section 394 (d) (6) of the local government code which states "The barangay secretary shall keep an updated records of all inhabitants of the barangay containing the following items of information: name, address, place and date of birth, sex, civil status, citizenship, occupation, and other items of information as may be prescribed by law or ordinance" shall be fully implemented. Aside from being compliant with the law, MCIT enabled barangays will be effective in managing information. The computer based information system will provide information to the concerned individual/ barangay officials in the proper form at the proper time. This will ensure that legal documents acquired from barangay are reliable, accurate and dependable. Furthermore, the study will also provide the concerned LGU with basic knowledge management skills since knowledge mapping can be done using MCIT system. The system can be used to retrieve the list of experts from a certain LGU. This will help the LGU from barangay level to the provincial*

level in seeking professional assistance for their project. The system in return will help the knowledge workers in earning more income.

5. ***The General Public.*** *Since MCIT barangay is not just an information center but also a Telecenter, the study will make MCIT- enabled barangay as an outlet for the general public with affordable access to a variety of services using ICTs especially from government Online services such as NSO (e-Census), SSS (on-line inquiry), GSIS (e-GSIS), DTI (i-Reklamo Online Consumer Assistance) DBM (Electronic Procurement System), DFA (Passport Renewal Online Form), BIR (Electronic Tin Verification) and many others.*

6. ***Researcher.*** *Since the study looked into the aspects of information management resources and practices, extent of ICT usage, the level of the acceptability of the MCIT prototype and the factors that may affect the respondent's level of acceptance involving a total of one hundred seventeen (117) respondents from different barangays from selected municipalities of the Province of Laguna, the Research, IT Management and Decision Making capabilities of the researcher will surely be improved. In addition, the researcher was able to personally discern the problems met by concerned barangays and apply the right technology and management principles that would resolve the present unsatisfactory conditions. Furthermost, the researcher became one of the knowledgeable persons in the establishment of Multipurpose Community Information and Telecenter which in return will prepare him as future Information Technology Consultant and/or Manager.*

7. ***Future Researchers.*** *Before the establishment of MCIT in the different barangays in the country, its level of acceptability must first be known. The cost of establishing community telecenter must be known vis a vis the financial capabilities of the LGUs concerned. The findings and conclusions of the study will be significant to both allies and critics of Community Telecenter Movement.*

Obviously, the proposed study is a response to the challenge of bringing the rural villages out of isolation by making the information society to be more about inclusion rather than exclusion. Henceforth, the study will help in alleviating the digital divide in the country if not in the whole world.

Scope and Limitation of the Study

The section may be subdivided into two parts, the Scope and Delimitation and Limitation of the Study.

The Scope and Delimitation of the Study should include a brief statement of the general purpose of the study, the target users/beneficiaries of the study, the period of the study and the features of the proposed software.

The limitation of the study includes the weaknesses of the study beyond the control of the researcher. This section may be not be included in the study if there is no such weaknesses of the study beyond the control of the researcher.

Example: (Development and Evaluation of CAI of Biological Science for the Second Year students of Laguna State Polytechnic College – Cabuyao Campus")[26]

SCOPE AND DELIMITATIONS

The study involved the development and testing of the effectiveness of CAI in the teaching and learning of human muscular system. The researcher was responsible in gathering the necessary data and information in developing the lessons. In developing the CAI, however, she sought the assistance of the programmer.

The study was confined to three groups of Natural Science students of Laguna State Polytechnic College for the first semester of the school year 2000 - 2001.

The subject matter focused on the human muscular system, which include the following particular topics: Types and Structure of Muscle; and, Skeletal Contraction and Energy Sources for Muscle Contraction. These topics were discussed for six meetings of one hour each. The study dealt largely on the evaluation of the effectiveness of CAI alone and the use of combination of CAI and the teacher-directed method.

The data of the study were drawn from the test results. Other factors like age, school, home, and peer factors were not considered in the study. Subjects profile was considered to provide reference if in case other variables affect the reliability obtained.

This study has no limitation that is beyond the control of the researcher.

Analogy:

Subject Scope of CAI: Muscular System

The scope is muscular system. The CAI did not include other systems such as Digestive system, circulatory system and the like. The researcher delimited the scope. The researcher might include additional systems of the human body if he wants to.

The above illustration is more on an educational research involving pedagogy. In a capstone project involving software development, this section should explicitly states the limitation of the software or system product which might be expected by a reasonable, discreet target beneficiaries or end users.

[26] Leah V. Mendoza, Development and Evaluation of CAI of Biological Science for the Second Year students of Laguna State Polytechnic College – Cabuyao Campus (Unpublished Thesis,2001)

To illustrate, in a capstone project entitled "Development and Evaluation of Classroom Schedule Generator (CSG): An Expert System Using Microsoft Visual Basic"[27] part of the delimitation of the capstone project includes:

The proposed Classroom Schedule Generator (CSG) shall automatically generate schedules using the following scheduling template or any two-day combination of any class schedule:

M-Th – Mondays and Thursdays;
Tue-Fri – Tuesdays and Fridays;
Wed – Sat – Wednesdays or Saturdays;

Thus, MWF, TTHS, or once a day schedule cannot be generated by the proposed CSG.

If the above delimitation was expressly stated during the proposal stage and was accepted and approved by the panel of examiners, then fairness, justice and equity dictates that any member of the panel of examiners cannot impose additional features during the final defense which was expressly stated in the Scope and Delimitation of the project.

Conversely, if the student did NOT reveal this delimitation in the Scope and Limitation and during oral examination, any suggestion of the panel examiners which is not clearly stated under this section, will be justifiable. Hence, the authors strongly suggest that the students/proponents should be open, transparent and honest in writing his thesis or capstone project proposal, the scope and limitation of his project.

In the research work entitled, "Human Resource E-leave Management: A Decision Support System",[28] the scope the limitation of the study was written in this wise:

SCOPE AND LIMITATIONS OF THE STUDY

The online leave management system was designed, developed and implemented taking the distinction of the leave of absence policies, types of leaves and the leave management of the university. This system was developed using the same technologies and tools used by the MIS team to maintain consistency in design and minimize problems in programming and conflicts in implementation when integrated to the whole HNUIIS.

The HRDM Officer advised that the study shall not include Solo Parent Leave and the Leave of Absence with Pay (study leave) because the drafting of the policies of such leave types is still ongoing. Further, the Leave of Absence with Pay (study leave) is not considered as one of the regular leaves because it is under the HRD Scholarship Program. The scope of this project is limited to several processes: handling of employees' leave applications, managing leave balances, records management, administration, leave management. It will generate the reports such as leave trends of the company, employee availability, employee leave balance, leave rejection, leave acceptance, employees with "no leave in the academic year", and absence monitoring."

Guide Format for Chapter 1 of BSIT, BSIS Capstone Project and BSCS Thesis:

Introduction

Objectives of the Study

Scope and Limitations

Significance of the Study

References

PERFORMANCE TASK 2

Prepare and submit your Chapter 1.

_____
_____
_____
_____.

Chapter 1

Paper Size – Letter 8.5 x 11 in

Font Style – Times New Roman 12

Spacing – Double Space; Justified

Margins - Left 1.5; Right, Top, Bottom – 1.0

Page Number – upper right (hide Chapter page number)

Note: No Heading/Header/Footer

Chapter 1

THE PROBLEM

Introduction

A world-class university producing leaders and change agents for social transformation and development. A world-class university producing leaders and change agents for social transformation and development (Author, Year). A world-class university producing leaders and change agents for social transformation and development.

The Bicol University shall give professional and technical training and provide advanced and specialized instruction in literature, philosophy, the sciences and arts, besides providing for the promotion of scientific and technological researches. The Bicol University shall give professional and technical training and provide advanced and specialized instruction in literature, philosophy, the sciences and arts, besides providing for the promotion of scientific and technological researches (Author, Year).

The proposed study will have a xxxxxxxxxxxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxxxx. The process will be xxxxxxxxxxxxxxxxxxxxxxxx xxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxxxx xxxxxxxxxxxxxx.

Objectives of the Study

The study aims to develop xxxxxxxxxxxx xxxxxxxxxxxxxxxxx xxxxxxxxxxxxxxx xxxxxxxxxxxxx. Specifically, it aims:

1. To determine the xxxxxxxxxxxx xxxxxxxxxxxxx in terms of: a) xxxxxxxxxx; b) xxxxxxxxxx; and c) xxxxxxxxxxxxxxxxx.

2. To design and develop a xxxxxxxxxxxxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx.

3. To evaluate the system in terms of xxxxxxxxxxxxx xxxxxxxxxxxxxx xxxxxxxxxxxxxxx.

Scope and Limitation

The propose project xxxxxxxxxxxx xxxxxxxxxxxxxxxx xxxxxxxxxx will be design and develop for xxxxxxxxxxxxxxxxxxxxxxxx.

The propose project will provide a xxxxxxxxxxxx xxxxxxxxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxxx.

The propose project not provide a xxxxxxxxxxxx xxxxxxxxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxxx.

Significance of the Study

The study focused on xxxxxxxxxxxxx xxxxxxxxxxxxxxxxx xxxxxxxxxxx xxxxxxxxxxxxxx. The results of the study will be beneficial to the following:

Bicol University Polangui Campus. This study will be a xxxxxxxxxxxxxx xxxxxxxxxxxxxx xxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxxx.

BUPC Personnel. This study will be a xxxxxxxxxxxxxx xxxxxxxxxxxxxx xxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxx.

BUPC Students. This study will be a xxxxxxxxxxxxxx xxxxxxxxxxxxxx xxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxxx.

Researchers. This study will be a xxxxxxxxxxxxxx xxxxxxxxxxxxxx xxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxxx.

Future Researchers. The findings of the study will serve as a xxxxxxxxxxxxxx xxxxxxxxxxxxxx xxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxxx.

REFERENCES

Use APA 6 Format

McKenzie, H., Boughton, M., Hayes, L., & Forsyth, S. (2008). Explaining the complexities and value of nursing practice and knowledge. In I. Morley & M. Crouch (Eds.), *Knowledge as value: Illumination through critical prisms* (pp. 209-224). Amsterdam, Netherlands: Rodopi.

APA 6 Format https://libguides.library.usyd.edu.au/c.php?g=508212&p=3476096

The APA in text reference is in the format **(author, date)**. When directly quoting from a text you must include a page number in the citation as given in the examples below. Including page numbers in all other circumstances is not required however, it is best practice to do so when referring to part of a work (e.g. a paragraph or chapter in a book). When referring to an entire work that covers a single topic (e.g. a journal article) it is not required.

Referencing an idea

> Anxiety and depression have been identified as more commonly in children and adolescents with long-term physical conditions (Dantzer, 2003, Pinquart & Shen, 2011).

OR

> Dantzer (2003), Pinquart and Shen (2011) all state that anxiety and depression has been identified as more commonly in children and adolescents with long-term physical conditions.

Referencing a quotation

> Indeed, one researcher commented that "technological innovations have saved or extended the lives of many patients" (Lumby, 2001, p. 44).

Citing a source within a source

Where your source quotes or refers to another source, for example Unsworth refers to previous work by Halliday on linguistics, the citation might read thus:

> (Halliday, as cited in Unsworth, 2004, p. 15)

Only Unsworth will appear in the *Reference list* at the end of your assignment

Reference List

Your reference list should be ordered alphabetically by author and then chronologically by year of publication. The APA 6th style requires the references to be indented as illustrated below in the examples.

For instances of multiple articles with the same authors and years of publication, please check the APA publication manual or Academic Writer. If you have the DOI for the journal article, you should include it in the reference, otherwise, it is not necessary.

Book

> De Vaus, D. A. (2014). *Surveys in social research*. Sydney, Australia: Allen & Unwin.

Book chapter

> McKenzie, H., Boughton, M., Hayes, L., & Forsyth, S. (2008). Explaining the complexities and value of nursing practice and knowledge. In I. Morley & M. Crouch (Eds.), *Knowledge as value: Illumination through critical prisms* (pp. 209-224). Amsterdam, Netherlands: Rodopi.

Journal article

Cheung, J. M. Y., Bartlett, D. J., Armour, C. L., Laba, T. L., & Saini, B. (2018). To drug or not to drug: A qualitative study of patients' decision-making processes for managing insomnia. *Behavioral Sleep Medicine*, *16*(1), 1-26. doi:10.1080/15402002.2016.1163702

Webpage with an author

HealthTimes. (2015). The future of aged care nursing in Australia. Retrieved from https://healthtimes.com.au/hub/aged-care/2/news/nc1/the-future-of-aged-care-nursing-in-australia/495/

Webpage with no author

$250m funding boost for malaria vaccine. (2003). Retrieved from https://www.abc.net.au/news/2003-09-22/250m-funding-boost-for-malaria-vaccine/1482220

Newspaper article

Fellner, C. (2019, April 7). Time bomb: Two new cases as NSW faces worst measles outbreak in years. *The Sydney Morning Herald*. Retrieved from https://www.smh.com.au

Government publication

Australian Institute of Health and Welfare. (2018). *Physical activity across the life stages*. Canberra, Australia: Author.

Australian Institute of Health and Welfare. (2018). *Physical activity across the life stages*. Retrieved from https://www.aihw.gov.au/reports/physical-activity/physical-activity-across-the-life-stages/contents/table-of-contents

Company and Industry Reports

Vuong, B. (2018, November). *IBISWorld industry report OD5381. Coffee shops in Australia*. Retrieved from IBISWorld database.

STUDY GUIDE

3 WRITING THE COMPONENTS OF CHAPTER 2

INTENDED LEARNING OUTCOMES

At the end of this lesson, the student is expected to:

- Know the objectives of citing related literatures and studies;
- Recognize the guidelines in citing related literatures and studies;
- Determine the instances when to quote or paraphrase sources;
- Avoid plagiarism during the research process; and
- Develop and compile an appropriate related literatures and studies.

WRITING THE REVIEW OF RELATED LITERATURES AND STUDIES

A researcher needs to review write-ups, readings, and studies related to his/her present study. A review of related literature (RRL) is a detailed review of existing literature related to the topic of a thesis. In an RRL, you talk about knowledge and findings from existing literature relevant to your topic. If you find gaps or conflicts in existing literature, you can also discuss these in your review, and if applicable, how you plan to address these gaps or resolve these conflicts through your study.[1]

LITERATURE REVIEW: CONDUCTING & WRITING[2]

This guide will provide research and writing tips to help students complete a literature review assignment.

1. Choose a topic. Define your research question.

Your literature review should be guided by a central research question. Remember, it is not a collection of loosely related studies in a field but instead represents background and research developments related to a specific research question, interpreted and analyzed by you in a synthesized way.

- Make sure your research question is not too broad or too narrow. Is it manageable?
- Begin writing down terms that are related to your question. These will be useful for searches later.
- If you have the opportunity, discuss your topic with your professor.

2. Decide on the scope of your review.

How many studies do you need to look at? How comprehensive should it be? How many years should it cover?

This may depend on your assignment. How many sources does the assignment require?

[1] https://www.editage.com/insights/samples-of-rrl
[2] https://libguides.uwf.edu/c.php?g=215199&p=1420520

3. Select the databases you will use to conduct your searches.

Make a list of the databases you will search. Remember to include comprehensive databases, you may find it thru research guides.

4. Conduct your searches and find the literature. Keep track of your searches!

- Review the abstracts of research studies carefully. This will save you time.
- Write down the searches you conduct in each database so that you may duplicate them if you need to later (or avoid dead-end searches that you'd forgotten you'd already tried).
- Use the bibliographies and references of research studies you find to locate others.
- Ask your professor or a scholar in the field if you are missing any key works in the field.
- Keep track of your research citations.

5. Review the literature.

Some questions to help you analyze the research:

- What was the research question of the study you are reviewing? What were the authors trying to discover?
- Was the research funded by a source that could influence the findings?
- What were the research methodologies? Analyze its literature review, the samples and variables used, the results, and the conclusions. Does the research seem to be complete? Could it have been conducted more soundly? What further questions does it raise?
- If there are conflicting studies, why do you think that is?
- How are the authors viewed in the field? Has this study been cited?; if so, how has it been analyzed?
- Again, review the abstracts carefully.
- Keep careful notes so that you may track your thought processes during the research process.

AIM OF LITERATURE REVIEW

The aim of a literature review is to show the reader what the researchers have read, and have a good grasp of, the main published work concerning a particular topic or question in the particular field. This work may be in any format, including online sources. It may be a separate assignment, or one of the introductory sections of a report or thesis. In the latter cases in particular, the review will be guided by the research objective or by the issue or thesis arguments and will provide the framework for further work.[3]

It is very important to note that the review should not be simply a description of what others have published in the form of a set of summaries, but should take the form of a critical discussion, showing insight and an awareness of differing arguments, literatures and approaches. It should be a synthesis and analysis of the relevant published work, linked at all times to your own purpose and rationale.[4]

[3] Birmingham City University. How to Write a Literature Review. Birmingham.
[4] Outcomes-Based Practical Guide to Thesis and Capstone Project Writing in Computing, Charlemagne G. Lavina, et al (2016)

ELEMENTS OF LITERATURE REVIEW[5]

1. An overview of the subject, issue or theory under consideration, along with the objectives of the literature review;
2. Division of works under review into categories (e.g. those in support of a particular position, those against, and those offering alternative theses entirely);
3. Explanation of how each work is similar to and how it varies from the others;
4. Conclusions as to which pieces are best considered in their argument, are most convincing of their opinions, and make the greatest contribution to the understanding and development of their area of research.

A good literature review therefore, is crucial and essential of what has been written because it determines new areas of controversy, and leads to another researchable problems worthy of further study.

SAMPLE OF LITERATURE REVIEW

Nonverbal communication may take a back seat to verbal communication. It is often overlooked and may be deemed unimportant. However, this aspect of communication speaks volumes. Nonverbal communication may consist of looking, smiling, frowning, touching, or expressions of surprise (Weisfeld and Stack, 2018).

In the study of Buck and Dyer (2019) also suggested that this is true. Focusing on nonverbal communication and its relationship to marital complaints, they found that wives who had husbands who were good communicators tended to have more complaints about their husbands. Their hypothesis was that because men are expected to tone down their emotions, having good nonverbal communication skills may be seen as socially unacceptable to their wives.

Marriage is the basis of most families in many cultures. Keeping the marital bond strong could be very difficult in the face of a chronic physical illness. A chronic physical illness could potentially change the daily lives and interactions of the entire marital relationship. It is important to discuss the communication that occurs around theses illnesses in order to understand how those who have one have been treated since their diagnosis based on research already conducted around similar communication processes (Badr, Walker, Dickson and Acitelli, 2015).

RELATED STUDIES

Published as well as unpublished research studies are sources of materials which may be included. The research studies may also be identified as foreign or local.

[5] UC Santa Cruz University Library. Writing a Literature Review. Retrieved from http://guides.library.ucsc.edu/write-a-literature-review

DIFFERENT WAYS OF CITING LITERATURES and STUDIES

In-Text Citations: The Basics[6]

When using APA format, follow the author-date method of in-text citation. This means that the author's last name and the year of publication for the source should appear in the text, for example, (Jones, 1998), and a complete reference should appear in the reference list at the end of the paper.

If you are referring to an idea from another work but **NOT** directly quoting the material, or making reference to an entire book, article or other work, you only have to make reference to the author and year of publication and not the page number in your in-text reference. All sources that are cited in the text must appear in the reference list at the end of the paper.

In-Text Citation Capitalization, Quotes, and Italics/Underlining

- Always capitalize proper nouns, including author names and initials: D. Jones.
- If you refer to the title of a source within your paper, capitalize all words that are four letters long or greater within the title of a source: *Permanence and Change*. Exceptions apply to short words that are verbs, nouns, pronouns, adjectives, and adverbs: *Writing New Media*, *There Is Nothing Left to Lose*.
  (**Note:** in your References list, only the first word of a title will be capitalized: *Writing new media*.)
- When capitalizing titles, capitalize both words in a hyphenated compound word: *Natural-Born Cyborgs*.
- Capitalize the first word after a dash or colon: "Defining Film Rhetoric: The Case of Hitchcock's *Vertigo*."
- Italicize the titles of longer works such as books, edited collections, movies, television series, documentaries, or albums: *The Closing of the American Mind*; *The Wizard of Oz*; *Friends*.
- Put quotation marks around the titles of shorter works such as journal articles, articles from edited collections, television series episodes, and song titles: "Multimedia Narration: Constructing Possible Worlds;" "The One Where Chandler Can't Cry."
- If you are directly quoting from a work, you will need to include the author and year of publication. Introduce the quotation with a signal phrase that includes the author's last name followed by the date of publication in parentheses.
- According to Jones (1998), "Students often had difficulty using APA style, especially when it was their first time"

[6] https://owl.purdue.edu/owl/research_and_citation/apa6_style/apa_formatting_and_style_guide/in_text_citations_the_basics.html

- Jones (1998) found "students often had difficulty using APA style"; what implications does this have for teachers?

- If the author is not named in a signal phrase, place the author's last name, the year of publication, and the page number in parentheses after the quotation.

- She stated, "Students often had difficulty using APA style" (Jones, 1998), but she did not offer an explanation as to why.

Long Quotations

Place direct quotations that are 40 words or longer in a free-standing block of typewritten lines and omit quotation marks. Start the quotation on a new line, indented 1/2 inch from the left margin, i.e., in the same place you would begin a new paragraph. Type the entire quotation on the new margin, and indent the first line of any subsequent paragraph within the quotation 1/2 inch from the new margin. Maintain double-spacing throughout.

The parenthetical citation should come after the closing punctuation mark.
Jones's (1998) study found the following:

Students often had difficulty using APA style, especially when it was their first time citing sources. This difficulty could be attributed to the fact that many students failed to purchase a style manual or to ask their teacher for help.

Summary or Paraphrase

If you are paraphrasing an idea from another work, you only have to make reference to the author and year of publication in your in-text reference, but APA guidelines encourage you to also provide the page number (although it is not required).

According to Jones (1998), APA style is a difficult citation format for first-time learners.

APA style is a difficult citation format for first-time learners (Jones, 1998).

In-Text Citations: Author/Authors[7]

APA style has a series of important rules on using author names as part of the author-date system. There are additional rules for citing indirect sources, electronic sources, and sources without page numbers.

A Work by Two Authors: Name both authors in the signal phrase or in parentheses each time you cite the work. Use the word "and" between the authors' names within the text and use the ampersand in parentheses.

Research by Wegener and Petty (1994) supported...
(Wegener & Petty, 1994)

[7] https://owl.purdue.edu/owl/research_and_citation/apa6_style/apa_formatting_and_style_guide/in_text_citations_author_authors.html

A Work by Three to Five Authors: List all the authors in the signal phrase or in parentheses the first time you cite the source. Use the word "and" between the authors' names within the text and use the ampersand in parentheses.

(Kernis, Cornell, Sun, Berry, & Harlow, 1993)

In subsequent citations, only use the first author's last name followed by "et al." in the signal phrase or in parentheses.

(Kernis et al., 1993)
In *et al.*, *et* should not be followed by a period.

Six or More Authors: Use the first author's name followed by et al. in the signal phrase or in parentheses.

Harris et al. (2001) argued...

(Harris et al., 2001)

Unknown Author: If the work does not have an author, cite the source by its title in the signal phrase or use the first word or two in the parentheses. Titles of books and reports are italicized; titles of articles, chapters, and web pages are in quotation marks. APA style calls for capitalizing important words in titles when they are written in the text (but not when they are written in reference lists).

A similar study was done of students learning to format research papers ("Using Citations," 2001).

Note: In the rare case the "Anonymous" is used for the author, treat it as the author's name (Anonymous, 2001). In the reference list, use the name Anonymous as the author.

Organization as an Author: If the author is an organization or a government agency, mention the organization in the signal phrase or in the parenthetical citation the first time you cite the source.

According to the American Psychological Association (2000),...
If the organization has a well-known abbreviation, include the abbreviation in brackets the first time the source is cited and then use only the abbreviation in later citations.

First citation: (Mothers Against Drunk Driving [MADD], 2000)

Second citation: (MADD, 2000)

Two or More Works in the Same Parentheses: When your parenthetical citation includes two or more works, order them the same way they appear in the reference list (viz., alphabetically), separated by a semi-colon.

(Berndt, 2002; Harlow, 1983)

Two or More Works by the Same Author in the Same Parentheses: When your parenthetical citation includes two or more works from the same author, list the years of publication in sequence, with the earliest first. Provide in-press citations last. Only list authors' surnames once for each list of dates.

(Hoffa, 1956, 1962, 1975)

Following this pattern, multiple works from multiple authors can be contained within a single parenthetical. Separate authors' sources with a semicolon. Note, however, that the authors' names should be provided in the order they appear in the reference list regardless of when their sources were published.

(Jones, 2010, 2018, in press; Smith, 2002, 2003, 2004, 2006; Zepf, 2019)

Authors With the Same Last Name: To prevent confusion, use first initials with the last names.

(E. Johnson, 2001; L. Johnson, 1998)

Two or More Works by the Same Author in the Same Year: If you have two sources by the same author in the same year, use lower-case letters (a, b, c) with the year to order the entries in the reference list. Use the lower-case letters with the year in the in-text citation.

Research by Berndt (1981a) illustrated that...

Introductions, Prefaces, Forewords, and Afterwords: When citing an Introduction, Preface, Foreword, or Afterword in-text, cite the appropriate author and year as usual.

(Funk & Kolln, 1992)

Personal Communication: For interviews, letters, e-mails, and other person-to-person communication, cite the communicator's name, the fact that it was personal communication, and the date of the communication. Do not include personal communication in the reference list.

(E. Robbins, personal communication, January 4, 2001).

A. P. Smith also claimed that many of her students had difficulties with APA style (personal communication, November 3, 2002).

Citing Indirect Sources

If you use a source that was cited in another source, name the original source in your signal phrase. List the secondary source in your reference list and include the secondary source in the parentheses.

Johnson argued that...(as cited in Smith, 2003, p. 102).

Note: When citing material in parentheses, set off the citation with a comma, as above. Also, try to locate the original material and cite the original source.

Electronic Sources

If possible, cite an electronic document the same as any other document by using the author-date style.

Kenneth (2000) explained...

Unknown Author and Unknown Date: If no author or date is given, use the title in your signal phrase or the first word or two of the title in the parentheses and use the abbreviation "n.d." (for "no date").

Another study of students and research decisions discovered that students succeeded with tutoring ("Tutoring and APA," n.d.).

JUSTIFICATION OF THE PRESENT STUDY/PROJECT SYNTHESIS[8]

In this section, the researcher should be able to convince his reader that his thesis or capstone project is not a duplication of other's work. In case that the proposed thesis or capstone project is a continuation of a previous work, this section should give emhpasis or justification why the proposed thesis or capstone project as the case may be, is needed. Example of a good justification is when the previous work recommends that further improvement is needed to maximize the benefits of his work.

There may also be a need to continue with the present investigation to affirm or negate the findings of other inquiries about the same research problem or topic so that generalizations or principles may be formulated. These generalizations and principles would be the contributions of the present investigation together with other studies to the fund of knowledge.

Most computer science theses and IT/IS capstone projects uses "synthesis" in place of "justification of the study." Synthesis contains a conclusive summary of the related literature and studies.

COMMON GUIDELINES IN CITING RELATED LITERATURE and STUDIES

The following are the characteristics of related literature and studies that should be cited:

1. The materials must be as recent as possible.
2. Materials must be objective and unbiased as possible.
3. Materials must be relevant to the study.
4. Materials must not be too few but not too many.
5. After the reading, the readers should gain adequate understanding on the technical topic(s) involved in the thesis and/or capstone project.

[8] Outcomes-Based Practical Guide to Thesis and Capstone Project Writing in Computing, Charlemagne G. Lavina, et al (2016)

WHEN to SUMMARIZE, PARAPHRASE, and QUOTE[9]

Summarizing

Summaries are significantly shorter than the original material, and they take a broad overview of the source material as a whole. Summary must be cited with in-text citations and on your reference page.

Summarize when:

- You want to establish background or offer an overview of a topic
- You want to describe knowledge (from several sources) about a topic
- You want to determine the main ideas of a single source

Paraphrasing

Paraphrasing is stating an idea or passage in your own words. You must significantly change the wording, phrasing, and sentence structure (not just a few words here and there) of the source. These also must be noted with in-text citations and the reference page.

Paraphrase when:

- You want to clarify a short passage from a text
- You want to avoid overusing quotations
- You want to explain a point when exact wording isn't important
- You want to explain the main points of a passage
- You want to report numerical data or statistics (preferred in APA papers)

Quoting

Quotations are the exact words of an author, copied directly from a source, word for word. Quotations must appear with quotation marks, and they need to be cited with in-text citations and on the reference page.

Use quotations when:

- You want to add the power of an author's words to support your argument
- You want to disagree with an author's argument
- You want to highlight particularly eloquent or powerful phrases or passages
- You are comparing and contrasting specific points of view
- You want to note the important research that precedes your own

PLAGIARISM

Plagiarism is a common (and often misunderstood) problem that is often the result of a lack of knowledge and skills. Our mission is to support the education community with a comprehensive set of resources to help students write with integrity.[10]

Preventing Plagiarism when Writing[11]

In a research paper, you have to come up with your own original ideas while at the same time making reference to work that's already been done by others. But how can you tell where their ideas end and your own begin? What's the proper way to integrate sources

[9] https://writingcenter.gmu.edu/guides/when-to-summarize-paraphrase-and-quote
[10] https://www.plagiarism.org/
[11] https://www.plagiarism.org/article/preventing-plagiarism-when-writing

in your paper? If you change some of what an author said, do you still have to cite that author?

Confusion about the answers to these questions often leads to plagiarism. If you have similar questions or are concerned about preventing plagiarism, we recommend using the checklist below.

Consult with Your Instructor

Have questions about plagiarism? If you can't find the answers on our site or are unsure about something, you should ask your instructor. He or she will most likely be very happy to answer your questions. You can also check out the guidelines for citing sources properly. If you follow them and the rest of the advice on this page, you should have no problems with plagiarism.

Plan Your Paper

Planning your paper well is the first and most important step you can take toward preventing plagiarism. If you know you are going to use other sources of information, you need to plan how you are going to include them in your paper. This means working out a balance between the ideas you have taken from other sources and your own, original ideas. Writing an outline or coming up with a thesis statement in which you clearly formulate an argument about the information you find will help establish the boundaries between your ideas and those of your sources.

Take Effective Notes

One of the best ways to prepare for a research paper is by taking thorough notes from all of your sources so that you have much of the information organized before you begin writing. On the other hand, poor note-taking can lead to many problems-- including improper citations and misquotations, both of which are forms of plagiarism! To avoid confusion about your sources, try using different colored fonts, pens, or pencils for each one, and make sure you clearly distinguish your own ideas from those you found elsewhere. Also, get in the habit of marking page numbers, and make sure that you record bibliographic information or web addresses for every source right away-- finding them again later when you are trying to finish your paper can be a nightmare!

When in Doubt, Cite Sources

Of course you want to get credit for your own ideas. And, you don't want your instructor to think that you got all of your information from somewhere else. But if it is unclear whether an idea in your paper really came from you, or whether you got it from somewhere else and just changed it a little, you should always cite your source. Instead of weakening your paper and making it seem like you have fewer original ideas, this will actually strengthen your paper by:

- showing that you are not just copying other ideas but are processing and adding to them,
- lending outside support to the ideas that are completely yours, and
- highlighting the originality of your ideas by making clear distinctions between them and ideas you have gotten elsewhere

Make it Clear Who Said What

Even if you cite sources, ambiguity in your phrasing can often disguise the real source of any given idea, causing inadvertent plagiarism. Make sure when you mix your own ideas with those of your sources that you always clearly distinguish them. If you are discussing the ideas of more than one person, watch out for confusing pronouns. For example, imagine you are talking about Harold Bloom's discussion of James Joyce's opinion of Shakespeare, and you write: "He brilliantly portrayed the situation of a writer in society at that time." Who is the "He" in this sentence? Bloom, Joyce, or Shakespeare? Who is the "writer": Joyce, Shakespeare, or one of their characters? Always make sure to distinguish who said what, and give credit to the right person.

Know How to Paraphrase

A paraphrase is a restatement in your own words of someone else's ideas. Changing a few words of the original sentences does NOT make your writing a legitimate paraphrase. You must change both the words and the sentence structure of the original, without changing the content. Also, you should keep in mind that paraphrased passages still require citation because the ideas came from another source, even though you are putting them in your own words.

The purpose of paraphrasing is not to make it seem like you are drawing less directly from other sources or to reduce the number of quotations in your paper. It is a common misconception among students that you need to hide the fact that you rely on other sources. Actually it is advantageous to highlight the fact that other sources support your own ideas. Using quality sources to support your ideas makes them seem stronger and more valid. Good paraphrasing makes the ideas of the original source fit smoothly into your paper, emphasizing the most relevant points and leaving out unrelated information.

Analyze and Evaluate Your Sources

Not all sources on the web are worth citing-- in fact, many of them are just plain wrong. So how do you tell the good ones apart? For starters, make sure you know the author(s) of the page, where they got their information, and when they wrote it (getting this information is also an important step in avoiding plagiarism!). Then you should determine how credible you feel the source is: how well they support their ideas, the quality of the writing, the accuracy of the information provided, etc.

CONCEPTUAL FRAMEWORK

The simplest way to explain a “conceptual framework” is that: **it is a diagram representing the relationship of variables**.[12]

We have to understand that researchers work to examine particular aspects of the world. In doing so, they create literature where they study and propose how these certain aspects of the world relate to one another. But in explaining complex relationships, the easiest, simplest, and most effective way of delivering them is through a particular diagram called a “conceptual framework”.

Though, conceptual frameworks do not always have to be in the scientific literature. Even the average person can create their own. However, truly scientific and authoritative ones are typically found inside scientific literature. Moreover, researchers do not just create

[12] https://topnotcher.ph/how-to-make-a-conceptual-framework/

conceptual frameworks out of nowhere. In fact, they conduct comprehensive reviews of literature which support their conceptual framework which makes their conceptual frameworks even more credible.

How to Make a Conceptual Framework?
Before you prepare your conceptual framework, you need to do the following things:

1. Choose your topic

As a researcher, there are many aspects of the world you can choose to investigate. However, the important thing to consider is that not all the resources of the world are available to us. Moreover, the research may also be time-bound. As such, one should choose a topic that they consider to be comprehensively achieved within the resources that they have and within the time they are allotted.

2. Make your research question

Unlike the topic which can be a broad area of study the research question has to be specific. The exact aspects of who, what, where, how, and why have to be clearly laid out. This is where one of the most important aspects of your conceptual framework will come in. The research question is a clear and arguable question which is where your research will revolve. In order to have a concise conceptual framework, your research question should be one that you are truly curious about.

A reason why the research question is an essential part of your conceptual framework and your overall research, this is what puts the focus and path of your study. It avoids the chances of getting lost as you write the paper.

3. Conduct a review of the literature

Doing a review of literature is an action where a researcher studies published works by reliable sources related to the topic. The purpose of having a literature review is to let you and your readers know about the existing ideas and information there are on your chosen topic; and as well as the weak and strong points of it. Some of the key things you should remember when doing the review of literature is that it should be: connected to the topic; synthesize the results of the publications you've read; and recognize the areas where there is a lack of information or insufficient evidence to prove the claim. By having a review of literature, this narrows down what you will be putting in your conceptual framework.

4. Choose your variables

Since you've done on your research, by this time, you will already be able to identify and pinpoint the variable that has been discussed in the publications you've studied and try to make a connection or decipher how they are linked. As you must have already read a lot of literature, you will find that there are many possible variables to choose from when conducting your study. However when creating research in general, it's important that you only choose the most important variables as not all of them will be significant; as you must have read much scientific literature, you should be able to discern the important ones by this point. And when creating a conceptual framework in particular, even though you can choose all the variables in the world, it would be best not to since too many variables in a conceptual framework will be confusing. Though it is also not a good idea to choose too few variables or else your study might be too simple. As also mentioned in the previous step, you have to find the right level of intricacy in your study that will fit within your resources and time allocation.

5. Choose your relationships

Now that you have chosen your variables, you have to choose how these variables are related to one another. Given that you have already read much literature on your topic, you should already be able to define how each of your variables is connected to one another. This is especially important to note as this will largely impact how your conceptual framework will look like once you start making the diagram.

6. Create the conceptual framework

Now that you have achieved all the previous steps, the final step is to illustrate the diagram. How you illustrate the diagram will differ on a case to case basis, but generally, variable names have to be laid out clearly and put into rectangles, variables have to be connected with lines and arrows, and the arrowheads will differ depending on the nature of the relationships. Single head arrows are for relationships that are one-directional (i.e. A affects B and B does not affect A) and double-headed arrows are for relationships that are 2 directional (i.e. A affects B and B also affects A). Also, lines do not have to be limited to connecting only 2 variables (i.e. A and B); some relationships can be between more variables (i.e. A affects B and also C).

Conceptual Framework Sample 1

Background: I am a co-owner of a branch of Burger King.

1. Choose your topic

I am interested to know what affects the satisfaction of our customers. My goal is to be able to know what specific parts of our business can influence our customers' experience.

2. Make your research question

The research question I can formulate is "What affects customer's satisfaction of Burger King?

3. Conduct a review of the literature

I read up on different publications related to food establishments, specifically burger joints, and customer satisfaction. From here, I can already have an idea of the variables I can pinpoint from those publications that have been proven to affect customer satisfaction.

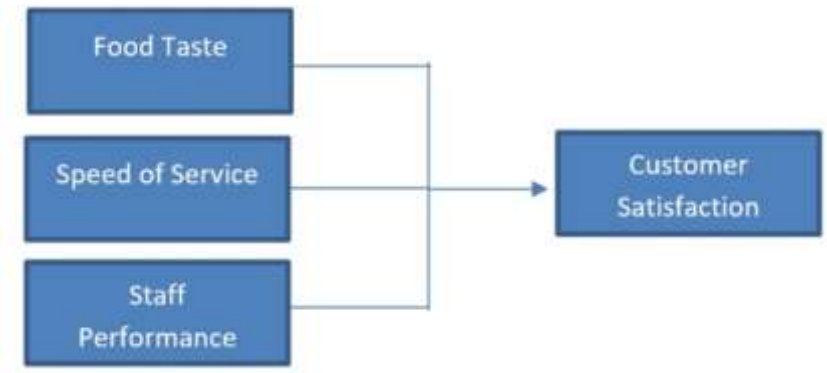
4. Choose your variables

With all the books, scholarly articles, and researches I have gone through, it can be determined that there are 3 main variables, namely: food taste, speed of service, and staff performance. Customers are very much concerned with the taste of the product. The amount of time it takes to serve them also affects how pleased or displeased they are. Lastly, the performance of the staff that serves also affects their experience.

5. Choose your relationships

I was able to determine that the 3 variables: food taste, speed of service, and staff performance, are determining factors of customer satisfaction.

6. Create the conceptual framework



Conceptual Framework Sample 2

Variables Isolated from the Literature

Using the background information backed by evidence in the literature review, we can now develop the study's paradigm on the effect of LED exposure to sleep. We will not include all of the variables mentioned and select or isolate only those factors that we are interested in.

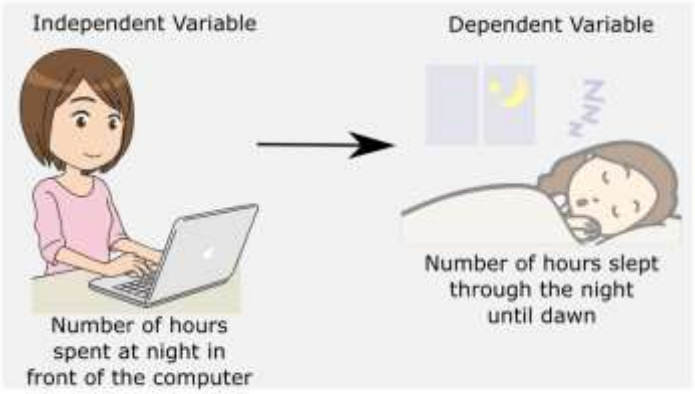


Fig. 1. The research paradigm illustrating the researcher's conceptual framework.

Figure 1 presents a visual representation, the paradigm, of what we want to correlate in this study. It shows measurable variables that can produce data that we can analyze using a statistical test such as either the parametric test **Pearson's Product Moment Correlation** or the **nonparametric Spearman Rho** test.

Notice that the variables of the study are explicit in the paradigm presented in Figure 1. In the illustration, the two variables are:

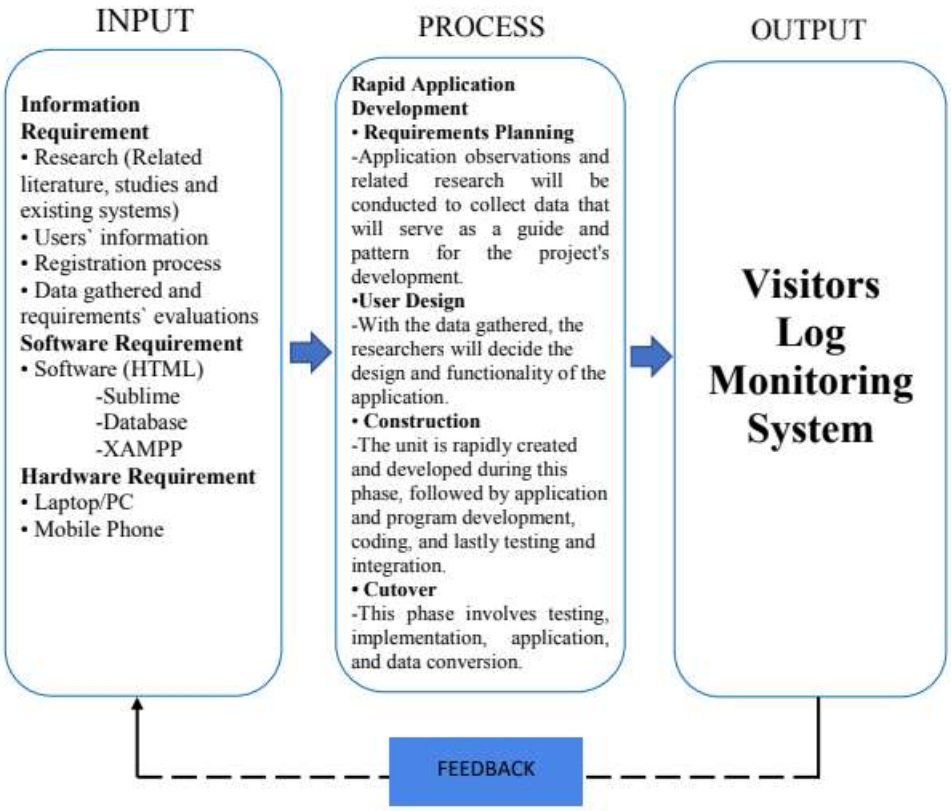
1) the number of hours devoted in front of the computer, and
2) the number of hours slept through the night until dawn.

The former is the independent variable, while the latter is the dependent variable. Both of these variables are easy to measure. It is just counting the number of hours spent in front of the computer and the number of hours slept through the night by the study subjects.

Assuming that other things are constant during the study's performance, it will be possible to relate these two variables and confirm that, indeed, blue light

emanated from computer screens can affect one's sleeping patterns. A correlation analysis will show whether the relationship is significant or not.

Conceptual Framework Sample 3 – Input, Process, Output



Input-Process-Output Model

Much of the work in organizations is accomplished through teams. It is therefore crucial to determine the factors that lead to effective as well as ineffective team processes and to better specify how, why, and when they contribute. Substantial research has been conducted on the variables that influence team effectiveness, yielding several models of team functioning. Although these models differ in a number of aspects, they share the commonality of being grounded in an input-process-output (IPO) framework. Inputs are the conditions that exist prior to group activity, whereas processes are the interactions among group members. Outputs are the results of group activity that are valued by the team or the organization.

The input-process-output model has historically been the dominant approach to understanding and explaining team performance and continues to exert a strong influence on group research today. The framework is based on classic systems theory, which states that the general structure of a system is as important in determining how effectively it will function as its individual components. Similarly, the IPO model has a causal structure, in that outputs are a function of various group processes, which are in turn influenced by numerous input variables. In its simplest form, the model is depicted as the following:

Input —> Process —> Output

Inputs

Inputs reflect the resources that groups have at their disposal and are generally divided into three categories: individual-level factors, group-level factors, and environmental factors. Individual-level factors are what group members bring to the group, such as motivation, personality, abilities, experiences, and demographic attributes. Examples of group-level factors are work structure, team norms, and group size. Environmental factors capture the broader context in which groups operate, such as reward structure, stress level, task characteristics, and organizational culture.

Processes

Processes are the mediating mechanisms that convert inputs to outputs. A key aspect of the definition is that processes represent interactions that take place among team members. Many different taxonomies of teamwork behaviors have been proposed, but common examples include coordination, communication, conflict management, and motivation.

In comparison with inputs and outputs, group processes are often more difficult to measure, because a thorough understanding of what groups are doing and how they complete their work may require observing members while they actually perform a task. This may lead to a more accurate reflection of the true group processes, as opposed to relying on members to self-report their processes retrospectively. In addition, group processes evolve over time, which means that they cannot be adequately represented through a single observation. These difficult methodological issues have caused many studies to ignore processes and focus only on inputs and outputs. Empirical group research has therefore been criticized as treating processes as a “black box” (loosely specified and unmeasured), despite how prominently featured they are in the IPO model. Recently, however, a number of researchers have given renewed emphasis to the importance of capturing team member interactions, emphasizing the need to measure processes longitudinally and with more sophisticated measures.

Outputs

Indicators of team effectiveness have generally been clustered into two general categories: group performance and member reactions. Group performance refers to the degree to which the group achieves the standard set by the users of its output. Examples include quality, quantity, timeliness, efficiency, and costs. In contrast, member reactions involve perceptions of satisfaction with group functioning, team viability, and personal development. For example, although the group may have been able to produce a high-quality product, mutual antagonism may be so high that members would prefer not to work with one another on future projects. In addition, some groups contribute to member well-being and growth, whereas others block individual development and hinder personal needs from being met.

Both categories of outcomes are clearly important, but performance outcomes are especially valued in the team literature. This is because they can be measured more objectively (because they do not rely on team member self-reports) and make a strong case that inputs and processes affect the bottom line of group effectiveness.

DEFINITION OF TERMS[13]

An alphabetical list of important terms or acronyms that you define, particularly ambiguous terms or those used in a special way.

Your thesis proposal will likely include terms that are not widely known outside of your discipline. These terms include particular theoretical constructs, formulas, operational definitions that differ from colloquial definitions, schools of thought and discipline-specific acronyms. This part of your proposal offers the reader a list of definitions of these terms.

- ***How you define such terms*** could considerably affect how the reader understands your thesis
- Be sure you ***use these terms in a consistent fashion*** throughout your proposal and thesis

Guide Format for Chapter 2 of BSIT, BSIS Capstone Project and BSCS Thesis:

Chapter 2: Related Literature and Studies

Related Literature (minimum of 3 literatures)

Related Studies (minimum of 3 studies)

Project Synthesis

Conceptual Framework

Definition of Terms

References

PERFORMANCE TASK 3

Prepare and submit your Chapter 2.

_____
_____
_____
_____.

[13] https://thesis.extension.harvard.edu/definition-terms

Chapter 2

RELATED LITERATURE AND STUDIES

This chapter presents the related literature and studies, project synthesis, conceptual framework and the definition of terms.

Related Literature

A world-class university producing leaders and change agents for social transformation and development. A world-class university producing leaders and change agents for social transformation and development (Author, Year). A world-class university producing leaders and change agents for social transformation and development.

The Bicol University shall give professional and technical training and provide advanced and specialized instruction in literature, philosophy, the sciences and arts, besides providing for the promotion of scientific and technological researches. The Bicol University shall give professional and technical training and provide advanced and specialized instruction in literature, philosophy, the sciences and arts, besides providing for the promotion of scientific and technological researches (Author, Year).

Related Studies

A world-class university producing leaders and change agents for social transformation and development. A world-class university producing leaders and change agents for social transformation and development (Author, Year). A world-class university producing leaders and change agents for social transformation and development.

The Bicol University shall give professional and technical training and provide advanced and specialized instruction in literature, philosophy, the sciences and arts,

besides providing for the promotion of scientific and technological researches. The Bicol University shall give professional and technical training and provide advanced and specialized instruction in literature, philosophy, the sciences and arts, besides providing for the promotion of scientific and technological researches (Author, Year).

Project Synthesis

The study of xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxxxxx. The significance of this to present study is xxxxxxxxxxxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxxxxx xxxxxxxxxxxxxx.

Conceptual Framework

The Bicol University shall give professional and technical training and provide advanced and specialized instruction in literature, philosophy, the sciences and arts, besides providing for the promotion of scientific and technological researches. The Bicol University shall give professional and technical training and provide advanced and specialized instruction in literature, philosophy, the sciences and arts, besides providing for the promotion of scientific and technological researches (Author, Year).

Figure 1. Conceptual Paradigm of the Study

Definition of Terms

The following terms are conceptually and operationally defined.

Bicol University Polangui Campus. definition from dictionary or valid sources xxxxxxxxxxxxxx xxxxxxxxxxxxxx xxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxxx (citation). In this study, xxxxxxxxxxxxxx xxxxxxxxxxxxxx xxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxxx.

BUPC Students. definition from dictionary or valid sources xxxxxxxxxxxxxx xxxxxxxxxxxxxx xxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxxx (citation). In this study, xxxxxxxxxxxxxx xxxxxxxxxxxxxx xxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxxx.

REFERENCES

Use APA 6 Format

McKenzie, H., Boughton, M., Hayes, L., & Forsyth, S. (2008). Explaining the complexities and value of nursing practice and knowledge. In I. Morley & M. Crouch (Eds.), *Knowledge as value: Illumination through critical prisms* (pp. 209-224). Amsterdam, Netherlands: Rodopi.

STUDY GUIDE

4 WRITING THE COMPONENTS OF CHAPTER 3

INTENDED LEARNING OUTCOMES

At the end of this lesson, the student is expected to:

- Know the general definition of research design;
- Know why educational research is undertaken and the audience that profit from research studies;
- Identify the overall process of designing a research study; and
- Be familiar with ethical issues in educational research, including those issues that arise in using quantitative and qualitative research

RESEARCH DESIGN[1]

Research design is the framework of research methods and techniques chosen by a researcher. The design allows researchers to hone in on research methods that are suitable for the subject matter and set up their studies up for success.

The design of a research topic explains the type of research (experimental, survey, correlational, semi-experimental, review) and also its sub-type (experimental design, research problem, descriptive case-study).

There are three main types of research design: Data collection, measurement, and analysis. The type of research problem an organization is facing will determine the research design and not vice-versa. The design phase of a study determines which tools to use and how they are used.

An impactful research design usually creates a minimum bias in data and increases trust in the accuracy of collected data. A design that produces the least margin of error in experimental research is generally considered the desired outcome. The essential elements of the research design are:

1. Accurate purpose statement
2. Techniques to be implemented for collecting and analyzing research
3. The method applied for analyzing collected details
4. Type of research methodology
5. Probable objections for research
6. Settings for the research study
7. Timeline
8. Measurement of analysis

[1] https://www.questionpro.com/blog/research-design/

Figure 1. Elements of Research Design

Proper research design sets your study up for success. Successful research studies provide insights that are accurate and unbiased. You'll need to create a survey that meets all of the main characteristics of a design. There are four key characteristics of research design:

Neutrality: When you set up your study, you may have to make assumptions about the data you expect to collect. The results projected in the research design should be free from bias and neutral. Understand opinions about the final evaluated scores and conclusion from multiple individuals and consider those who agree with the derived results.

Reliability: With regularly conducted research, the researcher involved expects similar results every time. Your design should indicate how to form research questions to ensure the standard of results. You'll only be able to reach the expected results if your design is reliable.

Validity: There are multiple measuring tools available. However, the only correct measuring tools are those which help a researcher in gauging results according to the objective of the research. The questionnaire developed from this design will then be valid.

Generalization: The outcome of your design should apply to a population and not just a restricted sample. A generalized design implies that your survey can be conducted on any part of a population with similar accuracy.

The above factors affect the way respondents answer the research questions and so all the above characteristics should be balanced in a good design.

A researcher must have a clear understanding of the various types of research design to select which model to implement for a study. Like research itself, the design of your study can be broadly classified into quantitative and qualitative.

Qualitative research design: Qualitative research determines relationships between collected data and observations based on mathematical calculations. Theories related to a naturally existing phenomenon can be proved or disproved using statistical methods. Researchers rely on qualitative research design methods that conclude "why" a particular theory exists along with "what" respondents have to say about it.

Quantitative research design: Quantitative research is for cases where statistical conclusions to collect actionable insights are essential. Numbers provide a better perspective to make critical business decisions. Quantitative research design methods are necessary for the growth of any organization. Insights drawn from hard numerical data and analysis prove to be highly effective when making decisions related to the future of the business.

TYPES OF RESEARCH DESIGNS[2]

Before beginning your paper, you need to decide how you plan to design the study. The research design refers to the overall strategy that you choose to integrate the different components of the study in a coherent and logical way, thereby, ensuring you will effectively address the research problem; it constitutes the blueprint for the collection, measurement, and analysis of data. Note that your research problem determines the type of design you can use, not the other way around!

General Structure and Writing Style[3]

The function of a research design is to ensure that the evidence obtained enables you to effectively address the research problem as unambiguously as possible. In social sciences research, obtaining evidence relevant to the research problem generally entails specifying the type of evidence needed to test a theory, to evaluate a program, or to accurately describe a phenomenon. However, researchers can often begin their investigations far too early, before they have thought critically about what information is required to answer the study's research questions. Without attending to these design issues beforehand, the conclusions drawn risk being weak and unconvincing and, consequently, will fail to adequate address the overall research problem.

Given this, the length and complexity of research designs can vary considerably, but any sound design will do the following things:

1. Identify the research problem clearly and justify its selection,
2. Review previously published literature associated with the problem area,
3. Clearly and explicitly specify hypotheses [i.e., research questions] central to the problem selected,
4. Effectively describe the data which will be necessary for an adequate test of the hypotheses and explain how such data will be obtained, and
5. Describe the methods of analysis which will be applied to the data in determining whether or not the hypotheses are true or false.

Action Research Design[4]

Definition and Purpose. The essentials of action research design follow a characteristic cycle whereby initially an exploratory stance is adopted, where an understanding of a problem is developed and plans are made for some form of interventionary strategy. Then the intervention is carried out (the action in Action Research) during which time, pertinent observations are collected in various forms. The new interventional strategies are carried out, and the cyclic process repeats, continuing until a sufficient understanding of (or implement able solution for) the problem is achieved. The

[2] https://library.sacredheart.edu/c.php?g=29803&p=185902
[3] Kirshenblatt-Gimblett, Barbara. Part 1, What Is Research Design? The Context of Design. Performance Studies Methods Course syllabus. New Yortk University, Spring 2006.
[4] Gall, Meredith. *Educational Research: An Introduction*. Chapter 18, Action Research. 8th ed. Boston, MA: Pearson/Allyn and Bacon, 2007; Kemmis, Stephen and Robin McTaggart. "Participatory Action Research." In *Handbook of Qualitative Research*. Norman Denzin and Yvonna S. Locoln, eds. 2nd ed. (Thousand Oaks, CA: SAGE, 2000), pp. 567-605.; Reason, Peter and Hilary Bradbury. *Handbook of Action Research: Participative Inquiry and Practice*. Thousand Oaks, CA: SAGE, 2001.

protocol is iterative or cyclical in nature and is intended to foster deeper understanding of a given situation, starting with conceptualizing and particularizing the problem and moving through several interventions and evaluations.

What do these studies tell you?

1. A collaborative and adaptive research design that lends itself to use in work or community situations.
2. Design focuses on pragmatic and solution-driven research rather than testing theories.
3. When practitioners use action research it has the potential to increase the amount they learn consciously from their experience. The action research cycle can also be regarded as a learning cycle.
4. Action search studies often have direct and obvious relevance to practice.
5. There are no hidden controls or preemption of direction by the researcher.

What these studies don't tell you?

1. It is harder to do than conducting conventional studies because the researcher takes on responsibilities for encouraging change as well as for research.
2. Action research is much harder to write up because you probably can't use a standard format to report your findings effectively.
3. Personal over-involvement of the researcher may bias research results.
4. The cyclic nature of action research to achieve its twin outcomes of action (e.g. change) and research (e.g. understanding) is time-consuming and complex to conduct.

Case Study Design[5]

Definition and Purpose. A case study is an in-depth study of a particular research problem rather than a sweeping statistical survey. It is often used to narrow down a very broad field of research into one or a few easily researchable examples. The case study research design is also useful for testing whether a specific theory and model actually applies to phenomena in the real world. It is a useful design when not much is known about a phenomenon.

What do these studies tell you?

1. Approach excels at bringing us to an understanding of a complex issue through detailed contextual analysis of a limited number of events or conditions and their relationships.
2. A researcher using a case study design can apply a variety of methodologies and rely on a variety of sources to investigate a research problem.
3. Design can extend experience or add strength to what is already known through previous research.
4. Social scientists, in particular, make wide use of this research design to examine contemporary real-life situations and provide the basis for the application of concepts and theories and extension of methods.
5. The design can provide detailed descriptions of specific and rare cases.

[5] Anastas, Jeane W. *Research Design for Social Work and the Human Services*. Chapter 4, Flexible Methods: Case Study Design. 2nd ed. New York: Columbia University Press, 1999; Stake, Robert E. *The Art of Case Study Research*. Thousand Oaks, CA: SAGE, 1995; Yin, Robert K. *Case Study Research: Design and Theory*. Applied Social Research Methods Series, no. 5. 3rd ed. Thousand Oaks, CA: SAGE, 2003.

What these studies don't tell you?

1. A single or small number of cases offers little basis for establishing reliability or to generalize the findings to a wider population of people, places, or things.
2. The intense exposure to study of the case may bias a researcher's interpretation of the findings.
3. Design does not facilitate assessment of cause and effect relationships.
4. Vital information may be missing, making the case hard to interpret.
5. The case may not be representative or typical of the larger problem being investigated.
6. If the criteria for selecting a case is because it represents a very unusual or unique phenomenon or problem for study, then your interpretation of the findings can only apply to that particular case.

Causal Design[6]

Definition and Purpose. Causality studies may be thought of as understanding a phenomenon in terms of conditional statements in the form, "If X, then Y." This type of research is used to measure what impact a specific change will have on existing norms and assumptions. Most social scientists seek causal explanations that reflect tests of hypotheses. Causal effect (nomothetic perspective) occurs when variation in one phenomenon, an independent variable, leads to or results, on average, in variation in another phenomenon, the dependent variable.

Conditions necessary for determining causality:

- Empirical association--a valid conclusion is based on finding an association between the independent variable and the dependent variable.
- Appropriate time order--to conclude that causation was involved, one must see that cases were exposed to variation in the independent variable before variation in the dependent variable.
- Nonspuriousness--a relationship between two variables that is not due to variation in a third variable.

What do these studies tell you?

1. Causality research designs helps researchers understand why the world works the way it does through the process of proving a causal link between variables and eliminating other possibilities.
2. Replication is possible.
3. There is greater confidence the study has internal validity due to the systematic subject selection and equity of groups being compared.

[6] Bachman, Ronet. *The Practice of Research in Criminology and Criminal Justice*. Chapter 5, Causation and Research Designs. 3rd ed. Thousand Oaks, CA: Pine Forge Press, 2007; Causal Research Design: Experimentation. Anonymous SlideShare Presentation; Gall, Meredith. *Educational Research: An Introduction*. Chapter 11, Nonexperimental Research: Correlational Designs. 8th ed. Boston, MA: Pearson/Allyn and Bacon, 2007; Trochim, William M.K. Research Methods Knowledge Base. 2006.

What these studies don't tell you?

1. Not all relationships are casual! The possibility always exists that, by sheer coincidence, two unrelated events appear to be related.
2. Conclusions about causal relationships are difficult to determine due to a variety of extraneous and confounding variables that exist in a social environment. This means causality can only be inferred, never proven.
3. If two variables are correlated, the cause must come before the effect. However, even though two variables might be causally related, it can sometimes be difficult to determine which variable comes first and therefore to establish which variable is the actual cause and which is the actual effect.

Cohort Design[7]

Definition and Purpose. Often used in the medical sciences, but also found in the applied social sciences, a cohort study generally refers to a study conducted over a period of time involving members of a population which the subject or representative member comes from, and who are united by some commonality or similarity. Using a quantitative framework, a cohort study makes note of statistical occurrence within a specialized subgroup, united by same or similar characteristics that are relevant to the research problem being investigated, rather than studying statistical occurrence within the general population. Using a qualitative framework, cohort studies generally gather data using methods of observation. Cohorts can be either "open" or "closed."

- Open Cohort Studies [dynamic populations, such as the population of Los Angeles] involve a population that is defined just by the state of being a part of the study in question (and being monitored for the outcome). Date of entry and exit from the study is individually defined, therefore, the size of the study population is not constant. In open cohort studies, researchers can only calculate rate based data, such as, incidence rates and variants thereof.
- Closed Cohort Studies [static populations, such as patients entered into a clinical trial] involve participants who enter into the study at one defining point in time and where it is presumed that no new participants can enter the cohort. Given this, the number of study participants remains constant (or can only decrease).

What do these studies tell you?

1. The use of cohorts is often mandatory because a randomized control study may be unethical. For example, you cannot deliberately expose people to asbestos; you can only study its effects on those who have already been exposed. Research that measures risk factors often relies on cohort designs.
2. Because cohort studies measure potential causes before the outcome has occurred, they can demonstrate that these “causes” preceded the outcome, thereby avoiding the debate as to which is the cause and which is the effect.

[7] Healy P, Devane D. “Methodological Considerations in Cohort Study Designs.” *Nurse Researcher* 18 (2011): 32-36; Levin, Kate Ann. Study Design IV: Cohort Studies. *Evidence-Based Dentistry* 7 (2003): 51–52; Study Design 101. Himmelfarb Health Sciences Library. George Washington University, November 2011; Cohort Study. Wikipedia.

3. Cohort analysis is highly flexible and can provide insight into effects over time and related to a variety of different types of changes [e.g., social, cultural, political, and economic, etc.].
4. Either original data or secondary data can be used in this design.

What these studies don't tell you?

1. In cases where a comparative analysis of two cohorts is made [e.g., studying the effects of one group exposed to asbestos and one that has not], a researcher cannot control for all other factors that might differ between the two groups. These factors are known as confounding variables.
2. Cohort studies can end up taking a long time to complete if the researcher must wait for the conditions of interest to develop within the group. This also increases the chance that key variables change during the course of the study, potentially impacting the validity of the findings.
3. Because of the lack of randominization in the cohort design, its external validity is lower than that of study designs where the researcher randomly assigns participants.

Cross-Sectional Design[8]

Definition and Purpose. Cross-sectional research designs have three distinctive features: no time dimension, a reliance on existing differences rather than change following intervention; and, groups are selected based on existing differences rather than random allocation. The cross-sectional design can only measure diffrerences between or from among a variety of people, subjects, or phenomena rather than change. As such, researchers using this design can only employ a relative passive approach to making causal inferences based on findings.

What do these studies tell you?

1. Cross-sectional studies provide a 'snapshot' of the outcome and the characteristics associated with it, at a specific point in time.
2. Unlike the experimental design where there is an active intervention by the researcher to produce and measure change or to create differences, cross-sectional designs focus on studying and drawing inferences from existing differences between people, subjects, or phenomena.
3. Entails collecting data *at* and *concerning* one point in time. While longitudinal studies involve taking multiple measures over an extended period of time, cross-sectional research is focused on finding relationships between variables at one moment in time.
4. Groups identified for study are purposely selected based upon existing differences in the sample rather than seeking random sampling.
5. Cross-section studies are capable of using data from a large number of subjects and, unlike observational studies, is not geographically bound.
6. Can estimate prevalence of an outcome of interest because the sample is usually taken from the whole population.

[8] Hall, John. "Cross-Sectional Survey Design." In Encyclopedia of Survey Research Methods. Paul J. Lavrakas, ed. (Thousand Oaks, CA: Sage, 2008), pp. 173-174; Helen Barratt, Maria Kirwan. Cross-Sectional Studies: Design, Application, Strengths and Weaknesses of Cross-Sectional Studies. Healthknowledge, 2009.

7. Because cross-sectional designs generally use survey techniques to gather data, they are relatively inexpensive and take up little time to conduct.

What these studies don't tell you?

1. Finding people, subjects, or phenomena to study that are very similar except in one specific variable can be difficult.
2. Results are static and time bound and, therefore, give no indication of a sequence of events or reveal historical contexts.
3. Studies cannot be utilized to establish cause and effect relationships.
4. Provide only a snapshot of analysis so there is always the possibility that a study could have differing results if another time-frame had been chosen.
5. There is no follow up to the findings.

Descriptive Design[9]

Definition and Purpose. Descriptive research designs help provide answers to the questions of who, what, when, where, and how associated with a particular research problem; a descriptive study cannot conclusively ascertain answers to why. Descriptive research is used to obtain information concerning the current status of the phenomena and to describe "what exists" with respect to variables or conditions in a situation.

What do these studies tell you?

1. The subject is being observed in a completely natural and unchanged natural environment. True experiments, whilst giving analyzable data, often adversely influence the normal behavior of the subject.
2. Descriptive research is often used as a pre-cursor to more quantitatively research designs, the general overview giving some valuable pointers as to what variables are worth testing quantitatively.
3. If the limitations are understood, they can be a useful tool in developing a more focused study.
4. Descriptive studies can yield rich data that lead to important recommendations.
5. Approach collects a large amount of data for detailed analysis.

What these studies don't tell you?

1. The results from a descriptive research cannot be used to discover a definitive answer or to disprove a hypothesis.
2. Because descriptive designs often utilize observational methods [as opposed to quantitative methods], the results cannot be replicated.
3. The descriptive function of research is heavily dependent on instrumentation for measurement and observation.

Experimental Design[10]

[9] Anastas, Jeane W. *Research Design for Social Work and the Human Services*. Chapter 5, Flexible Methods: Descriptive Research. 2nd ed. New York: Columbia University Press, 1999; McNabb, Connie. Descriptive Research Methodologies. Powerpoint Presentation; Shuttleworth, Martyn. Descriptive Research Design, September 26, 2008. Explorable.com website.

[10] Anastas, Jeane W. *Research Design for Social Work and the Human Services*. Chapter 7, Flexible Methods: Experimental Research. 2nd ed. New York: Columbia University Press, 1999; Chapter 2: Research Design,

Definition and Purpose. A blueprint of the procedure that enables the researcher to maintain control over all factors that may affect the result of an experiment. In doing this, the researcher attempts to determine or predict what may occur. Experimental Research is often used where there is time priority in a causal relationship (cause precedes effect), there is consistency in a causal relationship (a cause will always lead to the same effect), and the magnitude of the correlation is great. The classic experimental design specifies an experimental group and a control group. The independent variable is administered to the experimental group and not to the control group, and both groups are measured on the same dependent variable. Subsequent experimental designs have used more groups and more measurements over longer periods. True experiments must have control, randomization, and manipulation.

What do these studies tell you?

1. Experimental research allows the researcher to control the situation. In so doing, it allows researchers to answer the question, "what causes something to occur?"
2. Permits the researcher to identify cause and effect relationships between variables and to distinguish placebo effects from treatment effects.
3. Experimental research designs support the ability to limit alternative explanations and to infer direct causal relationships in the study.
4. Approach provides the highest level of evidence for single studies.

What these studies don't tell you?

1. The design is artificial, and results may not generalize well to the real world.
2. The artificial settings of experiments may alter subject behaviors or responses.
3. Experimental designs can be costly if special equipment or facilities are needed.
4. Some research problems cannot be studied using an experiment because of ethical or technical reasons.
5. Difficult to apply ethnographic and other qualitative methods to experimental designed research studies.

Exploratory Design[11]

Definition and Purpose. An exploratory design is conducted about a research problem when there are few or no earlier studies to refer to. The focus is on gaining insights and familiarity for later investigation or undertaken when problems are in a preliminary stage of investigation.

The goals of exploratory research are intended to produce the following possible insights:

- Familiarity with basic details, settings and concerns.
- Well-grounded picture of the situation being developed.

Experimental Designs. School of Psychology, University of New England, 2000; Experimental Research. Research Methods by Dummies. Department of Psychology. California State University, Fresno, 2006; Trochim, William M.K. Experimental Design. Research Methods Knowledge Base. 2006; Rasool, Shafqat. Experimental Research. Slideshare presentation.

[11] Cuthill, Michael. "Exploratory Research: Citizen Participation, Local Government, and Sustainable Development in Australia." *Sustainable Development* 10 (2002): 79-89; Taylor, P. J., G. Catalano, and D.R.F. Walker. "Exploratory Analysis of the World City Network." *Urban Studies* 39 (December 2002): 2377-2394; Exploratory Research.

- Generation of new ideas and assumption, development of tentative theories or hypotheses.
- Determination about whether a study is feasible in the future.
- Issues get refined for more systematic investigation and formulation of new research questions.
- Direction for future research and techniques get developed.

What do these studies tell you?

1. Design is a useful approach for gaining background information on a particular topic.
2. Exploratory research is flexible and can address research questions of all types (what, why, how).
3. Provides an opportunity to define new terms and clarify existing concepts.
4. Exploratory research is often used to generate formal hypotheses and develop more precise research problems.
5. Exploratory studies help establish research priorities.

What these studies don't tell you?

1. Exploratory research generally utilizes small sample sizes and, thus, findings are typically not generalizable to the population at large.
2. The exploratory nature of the research inhibits an ability to make definitive conclusions about the findings.
3. The research process underpinning exploratory studies is flexible but often unstructured, leading to only tentative results that have limited value in decision-making.
4. Design lacks rigorous standards applied to methods of data gathering and analysis because one of the areas for exploration could be to determine what method or methodologies could best fit the research problem.

Historical Design[12]

Definition and Purpose. The purpose of a historical research design is to collect, verify, and synthesize evidence from the past to establish facts that defend or refute your hypothesis. It uses secondary sources and a variety of primary documentary evidence, such as, logs, diaries, official records, reports, archives, and non-textual information [maps, pictures, audio and visual recordings]. The limitation is that the sources must be both authentic and valid.

What do these studies tell you?

1. The historical research design is unobtrusive; the act of research does not affect the results of the study.
2. The historical approach is well suited for trend analysis.
3. Historical records can add important contextual background required to more fully understand and interpret a research problem.

[12] Savitt, Ronald. "Historical Research in Marketing." *Journal of Marketing* 44 (Autumn, 1980): 52-58; Gall, Meredith. *Educational Research: An Introduction*. Chapter 16, Historical Research. 8th ed. Boston, MA: Pearson/Allyn and Bacon, 2007.

4. There is no possibility of researcher-subject interaction that could affect the findings.
5. Historical sources can be used over and over to study different research problems or to replicate a previous study.

What these studies don't tell you?

1. The ability to fulfil the aims of your research are directly related to the amount and quality of documentation available to understand the research problem.
2. Since historical research relies on data from the past, there is no way to manipulate it to control for contemporary contexts.
3. Interpreting historical sources can be very time consuming.
4. The sources of historical materials must be archived consistentally to ensure access.
5. Original authors bring their own perspectives and biases to the interpretation of past events and these biases are more difficult to ascertain in historical resources.
6. Due to the lack of control over external variables, historical research is very weak with regard to the demands of internal validity.
7. It rare that the entirety of historical documentation needed to fully address a research problem is available for interpretation, therefore, gaps need to be acknowledged.

Longitudinal Design[13]

Definition and Purpose. A longitudinal study follows the same sample over time and makes repeated observations. With longitudinal surveys, for example, the same group of people is interviewed at regular intervals, enabling researchers to track changes over time and to relate them to variables that might explain why the changes occur. Longitudinal research designs describe patterns of change and help establish the direction and magnitude of causal relationships. Measurements are taken on each variable over two or more distinct time periods. This allows the researcher to measure change in variables over time. It is a type of observational study and is sometimes referred to as a panel study.

What do these studies tell you?

1. Longitudinal data allow the analysis of duration of a particular phenomenon.
2. Enables survey researchers to get close to the kinds of causal explanations usually attainable only with experiments.
3. The design permits the measurement of differences or change in a variable from one period to another [i.e., the description of patterns of change over time].
4. Longitudinal studies facilitate the prediction of future outcomes based upon earlier factors.

What these studies don't tell you?

1. The data collection method may change over time.

[13] Anastas, Jeane W. *Research Design for Social Work and the Human Services*. Chapter 6, Flexible Methods: Relational and Longitudinal Research. 2nd ed. New York: Columbia University Press, 1999; Kalaian, Sema A. and Rafa M. Kasim. "Longitudinal Studies." In *Encyclopedia of Survey Research Methods*. Paul J. Lavrakas, ed. (Thousand Oaks, CA: Sage, 2008), pp. 440-441; Ployhart, Robert E. and Robert J. Vandenberg. "Longitudinal Research: The Theory, Design, and Analysis of Change." *Journal of Management* 36 (January 2010): 94-120; Longitudinal Study. Wikipedia.

2. Maintaining the integrity of the original sample can be difficult over an extended period of time.
3. It can be difficult to show more than one variable at a time.
4. This design often needs qualitative research to explain fluctuations in the data.
5. A longitudinal research design assumes present trends will continue unchanged.
6. It can take a long period of time to gather results.
7. There is a need to have a large sample size and accurate sampling to reach representativeness.

Observational Design[14]

Definition and Purpose. This type of research design draws a conclusion by comparing subjects against a control group, in cases where the researcher has no control over the experiment. There are two general types of observational designs. In direct observations, people know that you are watching them. Unobtrusive measures involve any method for studying behavior where individuals do not know they are being observed. An observational study allows a useful insight into a phenomenon and avoids the ethical and practical difficulties of setting up a large and cumbersome research project.

What do these studies tell you?

1. Observational studies are usually flexible and do not necessarily need to be structured around a hypothesis about what you expect to observe (data is emergent rather than pre-existing).
2. The researcher is able to collect a depth of information about a particular behavior.
3. Can reveal interrelationships among multifaceted dimensions of group interactions.
4. You can generalize your results to real life situations.
5. Observational research is useful for discovering what variables may be important before applying other methods like experiments.
6. Observation research designs account for the complexity of group behaviors.

What these studies don't tell you?

1. Reliability of data is low because seeing behaviors occur over and over again may be a time consuming task and difficult to replicate.
2. In observational research, findings may only reflect a unique sample population and, thus, cannot be generalized to other groups.
3. There can be problems with bias as the researcher may only "see what they want to see."
4. There is no possibility to determine "cause and effect" relationships since nothing is manipulated.
5. Sources or subjects may not all be equally credible.
6. Any group that is studied is altered to some degree by the very presence of the researcher, therefore, skewing to some degree any data collected (the Heisenburg Uncertainty Principle).

[14] Atkinson, Paul and Martyn Hammersley. “Ethnography and Participant Observation.” In *Handbook of Qualitative Research*. Norman K. Denzin and Yvonna S. Lincoln, eds. (Thousand Oaks, CA: Sage, 1994), pp. 248-261; Observational Research. Research Methods by Dummies. Department of Psychology. California State University, Fresno, 2006; Patton Michael Quinn. *Qualitiative Research and Evaluation Methods*. Chapter 6, Fieldwork Strategies and Observational Methods. 3rd ed. Thousand Oaks, CA: Sage, 2002; Rosenbaum, Paul R. *Design of Observational Studies*. New York: Springer, 2010.

Philosophical Design[15]

Definition and Purpose. Understood more as an broad approach to examining a research problem than a methodological design, philosophical analysis and argumentation is intended to challenge deeply embedded, often intractable, assumptions underpinning an area of study. This approach uses the tools of argumentation derived from philosophical traditions, concepts, models, and theories to critically explore and challenge, for example, the relevance of logic and evidence in academic debates, to analyze arguments about fundamental issues, or to discuss the root of existing discourse about a research problem. These overarching tools of analysis can be framed in three ways:

- Ontology -- the study that describes the nature of reality; for example, what is real and what is not, what is fundamental and what is derivative?
- Epistemology -- the study that explores the nature of knowledge; for example, on what does knowledge and understanding depend upon and how can we be certain of what we know?
- Axiology -- the study of values; for example, what values does an individual or group hold and why? How are values related to interest, desire, will, experience, and means-to-end? And, what is the difference between a matter of fact and a matter of value?

What do these studies tell you?

1. Can provide a basis for applying ethical decision-making to practice.
2. Functions as a means of gaining greater self-understanding and self-knowledge about the purposes of research.
3. Brings clarity to general guiding practices and principles of an individual or group.
4. Philosophy informs methodology.
5. Refine concepts and theories that are invoked in relatively unreflective modes of thought and discourse.
6. Beyond methodology, philosophy also informs critical thinking about epistemology and the structure of reality (metaphysics).
7. Offers clarity and definition to the practical and theoretical uses of terms, concepts, and ideas.

What these studies don't tell you?

1. Limited application to specific research problems [answering the "So What?" question in social science research].
2. Analysis can be abstract, argumentative, and limited in its practical application to real-life issues.
3. While a philosophical analysis may render problematic that which was once simple or taken-for-granted, the writing can be dense and subject to unnecessary jargon, overstatement, and/or excessive quotation and documentation.
4. There are limitations in the use of metaphor as a vehicle of philosophical analysis.

[15] Chapter 4, Research Methodology and Design. Unisa Institutional Repository (UnisaIR), University of South Africa; Labaree, Robert V. and Ross Scimeca. “The Philosophical Problem of Truth in Librarianship.” *The Library Quarterly* 78 (January 2008): 43-70; Maykut, Pamela S. *Beginning Qualitative Research: A Philosophic and Practical Guide*. Washington, D.C.: Falmer Press, 1994; *Stanford Encyclopedia of Philosophy*. Metaphysics Research Lab, CSLI, Stanford University, 2013.

5. There can be analytical difficulties in moving from philosophy to advocacy and between abstract thought and application to the phenomenal world.

Sequential Design[16]

Definition and Purpose. Sequential research is that which is carried out in a deliberate, staged approach [i.e. serially] where one stage will be completed, followed by another, then another, and so on, with the aim that each stage will build upon the previous one until enough data is gathered over an interval of time to test your hypothesis. The sample size is not predetermined. After each sample is analyzed, the researcher can accept the null hypothesis, accept the alternative hypothesis, or select another pool of subjects and conduct the study once again. This means the researcher can obtain a limitless number of subjects before finally making a decision whether to accept the null or alternative hypothesis. Using a quantitative framework, a sequential study generally utilizes sampling techniques to gather data and applying statistical methods to analze the data. Using a qualitative framework, sequential studies generally utilize samples of individuals or groups of individuals [cohorts] and use qualitative methods, such as interviews or observations, to gather information from each sample.

What do these studies tell you?

1. The researcher has a limitless option when it comes to sample size and the sampling schedule.
2. Due to the repetitive nature of this research design, minor changes and adjustments can be done during the initial parts of the study to correct and hone the research method. Useful design for exploratory studies.
3. There is very little effort on the part of the researcher when performing this technique. It is generally not expensive, time consuming, or workforce extensive.
4. Because the study is conducted serially, the results of one sample are known before the next sample is taken and analyzed.

What these studies don't tell you?

1. The sampling method is not representative of the entire population. The only possibility of approaching representativeness is when the researcher chooses to use a very large sample size significant enough to represent a significant portion of the entire population. In this case, moving on to study a second or more sample can be difficult.
2. Because the sampling technique is not randomized, the design cannot be used to create conclusions and interpretations that pertain to an entire population. Generalizability from findings is limited.
3. Difficult to account for and interpret variation from one sample to another over time, particularly when using qualitative methods of data collection.

[16] Rebecca Betensky, Harvard University, Course Lecture Note slides; Cresswell, John W. Et al. "Advanced Mixed-Methods Research Designs." In *Handbook of Mixed Methods in Social and Behavioral Research*. Abbas Tashakkori and Charles Teddle, eds. (Thousand Oaks, CA: Sage, 2003), pp. 209-240; Nataliya V. Ivankova. "Using Mixed-Methods Sequential Explanatory Design: From Theory to Practice." *Field Methods* 18 (February 2006): 3-20; Bovaird, James A. and Kevin A. Kupzyk. "Sequential Design." In *Encyclopedia of Research Design*. Neil J. Salkind, ed. Thousand Oaks, CA: Sage, 2010; Sequential Analysis. Wikipedia.

SOURCES OF DATA[17]

Sources of Data can be classified into 2 types. Statistical sources refer to data that are gathered for some official purposes and incorporate censuses and officially administered surveys. Non-statistical sources refer to the collection of data for other administrative purposes or for the private sector.

Following are the two sources of data:

1. Internal Source

- When data are collected from reports and records of the organisation itself, it is known as the internal source.
- For example, a company publishes its 'Annual Report' on Profit and Loss, Total Sales, Loans, Wages, etc.

2. External Source

- When data are collected from outside the organisation, it is known as the external source.
- For example, if a Tour and Travels Company obtains information on 'Karnataka Tourism' from Karnataka Transport Corporation, it would be known as external sources of data.

Types of Data

A) Primary Data

- Primary data means 'First-hand information' collected by an investigator.
- It is collected for the first time.
- It is original and more reliable.
- For example Population census conducted by the government of India after every 10 years.

B) Secondary Data

- Secondary data refers to 'Second-hand information'.
- These are not originally collected rather obtained from already published or unpublished sources.
- For example the Address of a person taken from the Telephone Directory or Phone number of a company taken from 'Just Dial'.

Methods of Collecting Primary Data

1. Direct Personal Investigation
2. Indirect Oral Investigation
3. Information Through Correspondents

[17] https://byjus.com/commerce/what-are-the-sources-of-data/

4. Telephonic Interview
5. Mailed Questionnaire
6. The questionnaire filled by enumerators

DATA GATHERING PROCEDURE[18]

There is not one "best" data collection technique — every process comes with pros and cons. Some methods are better for projects that only require quantitative data, while others are better for uncovering qualitative data.

What is the difference between quantitative and qualitative data?

Quantitative data is counted and expressed in numbers: *There are **five** fire hydrants on Main Street.* Qualitative data is based on attributes (or qualities): *The fire hydrants on Main Street are **yellow**.*

A combination of techniques that gathers both quantitative and qualitative information will yield the most comprehensive results.

So without further ado, let's talk about some data collection methods:

Observations

Making direct observations is a simple and unobtrusive way of collecting data. Gathering first-hand information in the field gives the observer a holistic perspective that helps them to understand the context in which the item being studied operates or exists.

The observations are recorded in field notes or on a mobile device if the observer is collecting data electronically (like with Fulcrum).

Some examples of observational data collection are building inspections, safety checklists, agricultural surveys, and damage assessments.

Observation is an effective method because it is straightforward and efficient: It doesn't typically require extensive training on the part of the data collector, and he or she is generally not dependent on other participants.

The biggest drawback of observational data is that it tends to be superficial and lack the context needed to provide a complete picture.

Surveys / Questionnaires

Questionnaires are a popular means of data collection because they are inexpensive and can provide a broad perspective. They can be conducted face-to-face, by mail, telephone, or Internet (in which case, they can include respondents from anywhere in the world).

Surveys are often used when information is sought from a large number of people or on a wide range of topics (where in-depth responses are not necessary). They can contain yes/no, true/false, multiple choice, scaled, or open-ended questions — or all of the above. The same survey can be conducted at spaced intervals to measure change over time.

Some of the advantages of surveys are that respondents can answer questions on their own time, and may answer more honestly as questionnaires provide anonymity

[18] https://www.fulcrumapp.com/blog/field-data-collection-methods

(whether real or perceived). And while the responses may be biased on the part of the participant, they are free from the collector's bias.

The main drawbacks are low response rate, delay in response, and the possibility of ambiguous or missing answers (and since questionnaires are a passive tool, it's usually not possible to receive clarification).

Tips for designing a survey

- Keep it short and simple
- Include an introduction with basic directions
- List questions in a logical sequence
- Avoid jargon and complex language
- Provide adequate space for answers

Interviews

Interviews can be conducted in person or by phone, and can be structured (using survey forms) or unstructured.

The downsides are that interviews require time and money to plan and execute — including interviewer training — and they require more cooperation on the part of the interviewee, who may be uncomfortable sharing personal information.

But there are also many benefits to interviews: They don't require the literacy on the part of the respondents, for one thing. For another, they allow the interviewer (especially a well-trained one) to uncover deep insight by clarifying and deep-diving into the respondent's answers, as well as by collecting nonverbal data.

Telephone interviews are less expensive than in-person interviews, and provide access to anyone in the world with a phone. They also provide a measure of anonymity that may encourage the respondent to be more forthcoming with their answers. But they lack the rich data of face-to-face interaction.

Focus Groups

A focus group is simply a group interview of people who all have something in common. They provide the same type of data as in-person interviews, but add a social element and offer a broader understanding of why a group thinks or behaves in a particular way.

Focus groups are useful when examining cultural values or other complex issues, but also have their drawbacks. Lack of privacy or anonymity can present a major obstacle, as can "group think," or the potential for the group to be dominated by one or two participants.

These sessions can be time-consuming and difficult, and require a leader who is skilled at creating a relaxed, welcoming environment, drawing out passive participants, and even dealing with conflict.

While those are the four most common data collection techniques, there are as many collection methods as there are types of data, such as self-reporting, document review, testing, oral histories, and case studies — just to name a few.

METHODOLOGY[19]

The methods section of a research paper provides the information by which a study's validity is judged. The method section answers two main questions: 1) How was the data collected or generated? 2) How was it analyzed? The writing should be direct and precise and written in the past tense.

Importance of a Good Methodology Section[20]

You must explain how you obtained and analyzed your results for the following reasons:

- **Readers need to know how the data was obtained** because the method you choose affects the results and, by extension, how you likely interpreted those results.
- Methodology is crucial for any branch of scholarship because **an unreliable method produces unreliable results and it misappropriates interpretations of findings**.
- In most cases, there are a variety of different methods you can choose to investigate a research problem. **Your methodology section of your paper should make clear the reasons why you chose a particular method or procedure**.
- **The reader wants to know that the data was collected or generated in a way that is consistent with accepted practice** in the field of study. For example, if you are using a questionnaire, readers need to know that it offered your respondents a reasonable range of answers to choose from.
- **The research method must be appropriate to the objectives of the study**. For example, be sure you have a large enough sample size to be able to generalize and make recommendations based upon the findings.
- **The methodology should discuss the problems that were anticipated and the steps you took to prevent them from occurring**. For any problems that did arise, you must describe the ways in which their impact was minimized or why these problems do not affect the findings in any way that impacts your interpretation of the data.
- Often in social science research, it is useful for other researchers to adapt or replicate your methodology. Therefore, **it is important to always provide sufficient information to allow others to use or replicate the study**. This information is particularly important when a new method had been developed or an innovative use of an existing method has been utilized.

Structure and Writing Style[21]

[19] https://library.sacredheart.edu/c.php?g=29803&p=185928
[20] Bem, Daryl J. Writing the Empirical Journal Article. Psychology Writing Center. University of Washington; Lunenburg, Frederick C. *Writing a Successful Thesis or Dissertation: Tips and Strategies for Students in the Social and Behavioral Sciences*. Thousand Oaks, CA: Corwin Press, 2008.
[21] Azevedo, L.F. et al. How to Write a Scientific Paper: Writing the Methods Section. Revista Portuguesa de Pneumologia 17 (2011): 232-238; Butin, Dan W. *The Education Dissertation A Guide for Practitioner Scholars*. Thousand Oaks, CA: Corwin, 2010; Carter, Susan. *Structuring Your Research Thesis*. New York: Palgrave

I. Groups of Research Methods

There are two main groups of research methods in the social sciences:

1. The **empirical-analytical group** approaches the study of social sciences in a similar manner that researchers study the natural sciences. This type of research focuses on objective knowledge, research questions that can be answered yes or no, and operational definitions of variables to be measured. The empirical-analytical group employs deductive reasoning that uses existing theory as a foundation for hypotheses that need to be tested. **This approach is focused on explanation**.
2. The **interpretative group is focused on understanding phenomenon in a comprehensive, holistic way**. This research method allows you to recognize your connection to the subject under study. Because the interpretative group focuses more on subjective knowledge, it requires careful interpretation of variables.

II. Content

An effectively written methodology section should:

- **Introduce the overall methodological approach for investigating your research problem**. Is your study qualitative or quantitative or a combination of both (mixed method)? Are you going to take a special approach, such as action research, or a more neutral stance?
- **Indicate how the approach fits the overall research design**. Your methods should have a clear connection with your research problem. In other words, make sure that your methods will actually address the problem. One of the most common deficiencies found in research papers is that the proposed methodology is unsuited to achieving the stated objective of your paper.
- **Describe the specific methods of data collection you are going to use**, such as, surveys, interviews, questionnaires, observation, and archival research. If you are analyzing existing data, such as a data set or archival documents, describe how it was originally created or gathered and by whom.
- **Explain how you intend to analyze your results**. Will you use statistical analysis? Will you use specific theoretical perspectives to help you analyze a text or explain observed behaviors?
- **Provide background and rationale for methodologies that are unfamiliar for your readers**. Very often in the social sciences, research problems and the methods for investigating them require more explanation/rationale than widely accepted rules governing the natural and physical sciences. Be clear and concise in your explanation.
- **Provide a rationale for subject selection and sampling procedure**. For instance, if you propose to conduct interviews, how do you intend to select the sample population? If you are analyzing texts, which texts have you chosen, and why? If you are using statistics, why is this set of statisics being used? If other data sources exist, explain why the data you chose is most appropriate.

Macmillan, 2012; Lunenburg, Frederick C. *Writing a Successful Thesis or Dissertation: Tips and Strategies for Students in the Social and Behavioral Sciences*. Thousand Oaks, CA: Corwin Press, 2008. Methods Section. The Writer's Handbook. Writing Center. University of Wisconsin, Madison; Writing the Experimental Report: Methods, Results, and Discussion. The Writing Lab and The OWL. Purdue University; Methods and Materials. The Structure, Format, Content, and Style of a Journal-Style Scientific Paper. Department of Biology. Bates College.

- **Address potential limitations**. Are there any practical limitations that could affect your data collection? How will you attempt to control for potential confounding variables and errors? If your methodology may lead to problems you can anticipate, state this openly and show why pursuing this methodology outweighs the risk of these problems cropping up.

NOTE: **Once you have written all of the elements of the methods section, subsequent revisions should focus on how to present those elements as clearly and as logically as possibly.** The description of how you prepared to study the research problem, how you gathered the data, and the protocol for analyzing the data should be organized chronologically. For clarity, when a large amount of detail must be presented, information should be presented in sub-sections according to topic.

III. Problems to Avoid

Irrelevant Detail. The methodology section of your paper should be thorough but to the point. Don't provide any background information that doesn't directly help the reader to understand why a particular method was chosen, how the data was gathered or obtained, and how it was analyzed.

Unnecessary Explanation of Basic Procedures. Remember that you are not writing a how-to guide about a particular method. You should make the assumption that readers possess a basic understanding of how to investigate the research problem on their own and, therefore, you do not have to go into great detail about specific methodological procedures. The focus should be on how you *applied a method*, not on the mechanics of *doing a method.* **NOTE:** An exception to this rule is if you select an unconventional approach to doing the method; if this is the case, be sure to explain why this approach was chosen and how it enhances the overall research process.

Problem Blindness. It is almost a given that you will encounter problems when collecting or generating your data. Do not ignore these problems or pretend they did not occur. Often, documenting how you overcame obstacles can form an interesting part of the methodology. It demonstrates to the reader that you can provide a cogent rationale for the decisions you made to minimize the impact of any problems that arose.

Literature Review. Just as the literature review section of your paper provides an overview of sources you have examined while researching a particular topic, the methodology section should cite any sources that informed your choice and application of a particular method [i.e., the choice of a survey should include any citations to the works you used to help construct the survey].

It's More than Sources of Information! A description of a research study's method should not be confused with a description of the sources of information. Such a list of sources is useful in itself, especially if it is accompanied by an explanation about the selection and use of the sources. The description of the project's methodology complements a list of sources in that it sets forth the organization and interpretation of information emanating from those sources.

SOFTWARE DEVELOPMENT METHODOLOGY[22]

Software development methodology is a process or series of processes used in software development. Again, quite broad but that it is things like a design phase, a development phase. It is ways of thinking about things like waterfall being a non-iterative kind of process. Generally it takes the form of defined phases. It is designed to describe the how of the life cycle of a piece of software.

It is also codified communication. So you're actually setting a set of norms between a group of people that say this is how you're going to work and this is how you're going to pass information between each of you in certain ways; whether that is documentation, whether that is discussion, whether that is drawings on paper.

So some examples

Surely there couldn't be that many different software development methodologies. There are as many as you can possibly find and pretty much any time someone has one and decides to vary it even slightly from an existing one, they will put a new label on it and call it something new. That makes it quite hard to be across all of the different types, like **agile, lean and waterfall.**

In software engineering, a **software development process** is the process of dividing software development work into distinct phases to improve design, product management, and project management. It is also known as a **software development life cycle** (**SDLC**). The methodology may include the pre-definition of specific deliverables and artifacts that are created and completed by a project team to develop or maintain an application. Most modern development processes can be vaguely described as agile. Other methodologies include waterfall, prototyping, iterative and incremental development, spiral development, rapid application development, and extreme programming. A life-cycle "model" is sometimes considered a more general term for a category of methodologies and a software development "process" a more specific term to refer to a specific process chosen by a specific organization.[23]

Software Development methodologies play a vital part in developing software. Custom software development companies use many methodologies for their day-to-day operations. There are certain advantages and disadvantages associated with each of them. The basic purpose of these methodologies is to provide smooth software development according to the project requirements.

The software development methodology is a framework that is used to structure, plan, and control the process development of an information system. In this kind of development methodology, the only concern of this software development process is that it does not involve any technical aspect but demands proper planning for the software development lifecycle.

[22] https://www.alliancesoftware.com.au/introduction-software-development-methodologies/
[23] Centers for Medicare & Medicaid Services (CMS) Office of Information Service (2008). *Selecting a development approach*. Webarticle. United States Department of Health and Human Services (HHS). Re-validated: March 27, 2008.

Below are the 12 mainly used software development methodologies with their advantages and disadvantages

1. Agile Software Development Methodology
2. DevOps Methodology
3. Scrum Development Methodology
4. Waterfall Model
5. Prototype Methodology
6. Feature Driven Development
7. Rapid Application Development (RAD)
8. Spiral Model
9. Dynamic Systems Development Model Methodology
10. Extreme Programming Methodology
11. Joint Application Development Methodology
12. Lean Development Methodology

1. Agile Software Development Methodology

Agile Software Development is an approach that is used to design a disciplined software management process which also allows some frequent alteration in the development project. This is a type of software development methodology that is one conceptual framework for undertaking various software engineering projects. It is used to minimize risk by developing software in short time boxes which are called iterations that generally last for one week to one month.

Advantages of Agile Development Methodology:

- Customer satisfaction by rapid, continuous delivery of useful software.
- People and interactions are emphasized rather than process and tools. Customers, developers and testers constantly interact with each other.

- Agile methodology has an adaptive approach that is able to respond to the changing requirements of the clients.
- Direct communication and constant feedback from customer representatives leave no space for any guesswork in the system.

Disadvantages of Agile Development Methodology:

- In the case of some software deliverables, especially the large ones, it is difficult to assess the effort required at the beginning of the software development life cycle.
- This methodology focuses on working software rather than documentation, hence it may result in a lack of documentation.
- The project can easily get taken off track if the customer representative is not clear what final outcome that they want.
- Only senior programmers are capable of taking the kind of decisions required during the development process. Hence it has no place for newbie programmers unless combined with experienced resources.

2. DevOps Methodology

DevOps is a popular term gaining a lot of attention because of the unconditional benefits it offers to its customers. The siloed process of Development and Operations is not the same as the inception of DevOps. These two departments are functioning together as a single team for all processes in the entire life-cycle. This works concurrently for all businesses. The continuous integration and continuous delivery model allow development and operational teams to perform everything simultaneously in development, quality assurance, security, and other operations.

Now businesses are turning more towards DevOps as an agile and lean approach that enables a crisp collaboration between all the stages of the development life cycle.

Advantages of DevOps

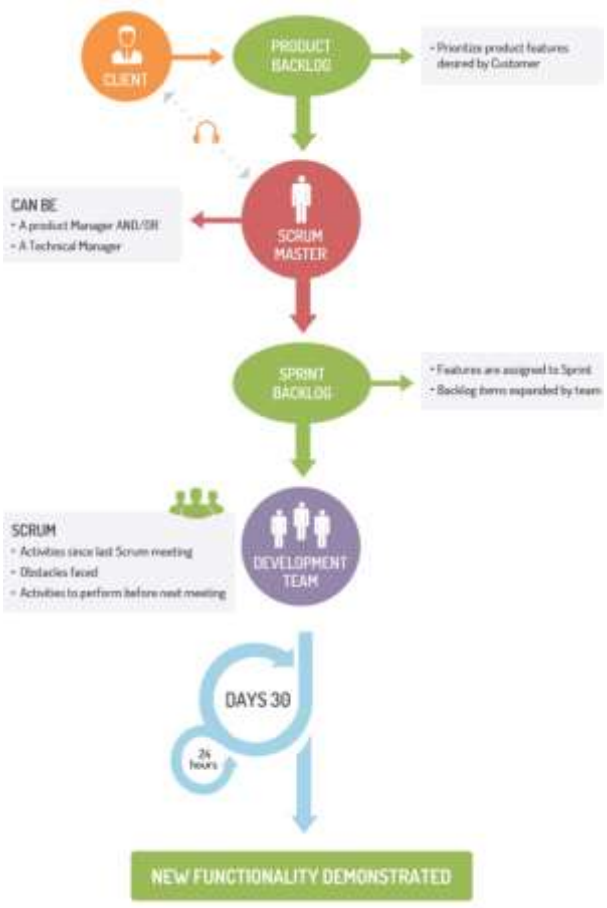
- **Faster Process** Multiple ongoing processes work simultaneously which makes the process faster and easier for businesses to process on time. By adapting to changes in the market, DevOps enables businesses to grow efficiently and drive definite business results.

- **Offers Rapid Deliveries** Microservices and Continuous delivery are some elements of DevOps that offer business continuity and recent updates rapidly. DevOps allows businesses to continuously innovate and improve products for a better software product.
- **Reliability** With increasing changes in the product and infrastructure, the developed products are robust and secure with a competitive advantage against all the peers.
- **Collaboration** This is a collaborative platform pillared on strong parameters of accountability and ownership. Both the development teams and operations team are in sync with all activities of the development lifecycle to deliver faster and effective products.

Disadvantages

- **DevOps demands Cultural change** Yes, this is true if you adopt DevOps in your business, it demands cultural change and business needs to restart their processes in order to grow efficiently.
- **Organizational Upgradation** is another important factor for companies to upgrade their business from conventional methods to dividing into multidisciplinary tasks that will allow them to use multiple skills at the same time.
- **Speed and security** is not something that is achieved all the time using DevOps. For some critical projects, there are companies that may not assure both in a single stage and you may need to consider a separate plan for security at every stage of your DevOps workflow.

3. Scrum Development Methodology



You can apply the Scrum Development Methodology in nearly all types of projects. For companies where the requirements are highly emerging and rapid changes are easily adhered to, we use this type of development method. The Scrum software development model begins with brief planning, meeting, and concludes with a final review. Businesses can accelerate the development of software using this method that allows a series of iterations in a single go. It is an ideal methodology because it easily brings on track even the slowest progressing projects.

Advantages of Scrum Development:

- Use Scrum Development for fast-moving, cutting-edge developments, rapid codes, and testing mistakes that can be easily rectified.
- In this methodology, decision-making is entirely in the hands of the teams.
- This methodology enables projects with the business requirements documentation and other signs that contribute to success.
- Enterprises can control the Project development steps visible in this method with empathizes on frequent updating of the progress.
- A daily meeting easily helps the developer to make it possible to measure individual productivity. This leads to the improvement in the productivity of each of the team members.
- Due to short sprints and constant feedback, it becomes easier to cope with the changes.
- It is easier to deliver a quality product at a scheduled time.

Disadvantages of Scrum Development:

- As one of the leading causes of scope creep is Agile Scrum thus there is no definite end date, the project management stakeholders will be tempted to keep demanding that new functionality be delivered.
- You should keep the estimation of project costs and time accurate if not then this kind of development model will suffer.
- It is good for small, fast-moving projects but not suitable for large size projects.
- This methodology needs experienced team members only. If the team consists of people who are novices, the project cannot be completed within an exact time frame.
- Scrum works well for project management when the Scrum Master trusts the team they are managing. If they practice too strict control over the team members, it can be extremely frustrating for them, leading to demoralization and the failure of the project.
- Project quality manager is hard to implement and quantify unless the test team is able to conduct regression testing after each sprint.

4. Waterfall Model

The **Waterfall Model** is one of the most traditional and commonly used software development methodologies. Most businesses consider this life cycle model as a classic style of software development. This model clarifies the software development process in a linear sequential flow. In any phase of the development cycle, you should always cross-check that the earlier phase is completed. This development approach does not define the process to go back to the previous phase to handle changes in requirements.

Advantages of the Waterfall Model:

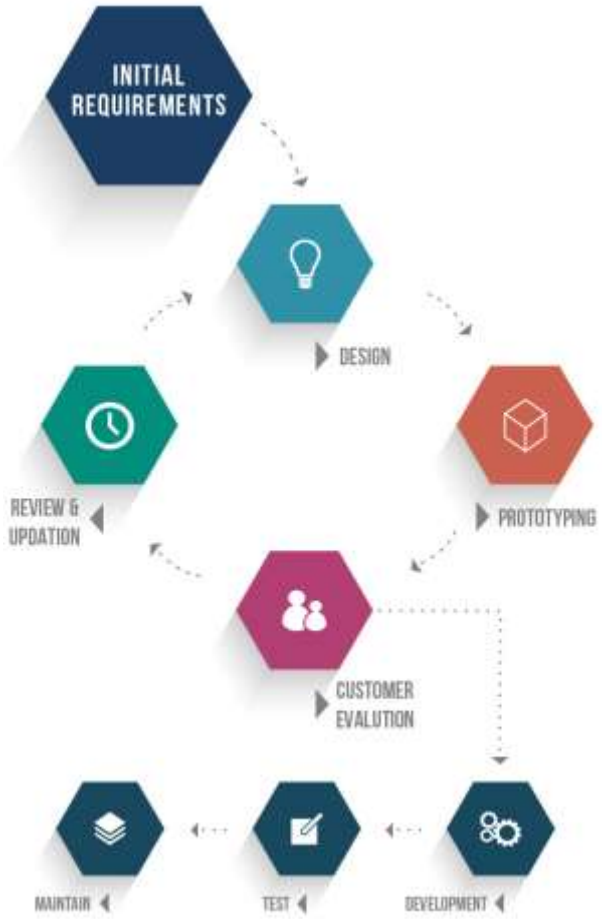
- Waterfall model is very simple and easy to understand and uses methodology. That is why it is beneficial for the beginner or novice developer.
- It is easy to manage the projects because of the rigidity of the model. Moreover, each phase has specific deliverables and an individual review process.
- This model saves a significant amount of time at all the phases processed and completed at a given time.
- The requirements are very well understood/defined in this type of development model. Also, it works effectively for smaller projects.
- You can easily do the testing that refers to the defined scenarios in the earlier functional specification.

Disadvantages of Waterfall Model:

- If the requirements are precise and are available up-front, then this model can only be used.
- This model is not applicable to projects that demand continuous maintenance.
- The main drawback of this method is that once an application is in the testing stage, it is not advisable to go back and do any amendments changes for completed software, it may cause a lot of problems.

- There is no possibility that we can to develop any working software until it reaches the last stage of the cycle
- You cannot include the client's valuable feedback within the ongoing development phase.
- In this model, there is no option to know the end result of the entire project
- Make your requirements well-defined and clear or else this model is not suitable. It is effective for long and ongoing projects.
- In this model, Documentation occupies a lot of time for developers and testers.

5. Prototype Methodology



The **Prototype Methodology** is the software development process that allows developers to create only the prototype of the solution to demonstrate its functionality to the clients. Make all the necessary modifications before developing the actual application using this methodology. The best feature of this software development methodology is that it solves a plethora of issues that often occur in a traditional waterfall model.

Advantages of Prototype Model:

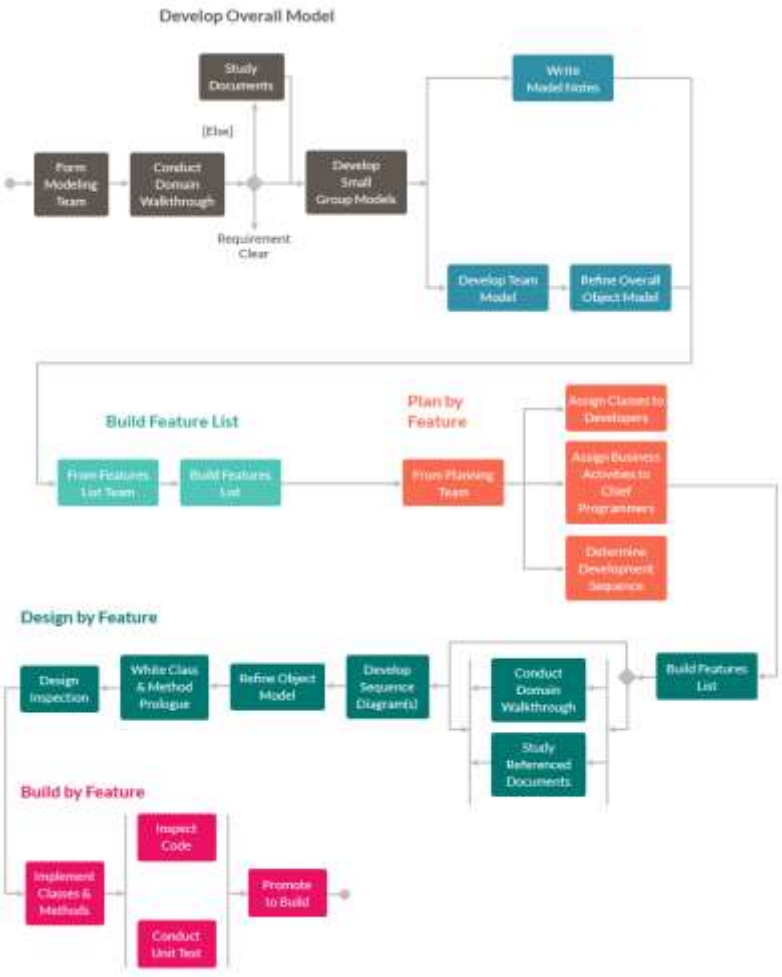
- Show the prototype to the client to have a clear understanding and complete 'feel' of the functionality developed in the software. It ensures a greater level of customer satisfaction and comfort.

- Identify the scope of the refinement and accordingly accommodate new changes in the given requirements.
- Significantly reduce the risk of failure using this method and identify the potential risks at an early stage and moderation steps can be taken quickly.
- The communication between the software development team and the client makes a very good and conducive environment during a project.
- It helps in requirement gathering and requirement analysis when there is a lack of required documents.

Disadvantages of Prototype Model:

- Prototyping is usually done at the cost of the developer so, it is should be done using minimal resources otherwise organization's development cost stretch too much.
- Customers sometimes demand the actual product to be delivered soon after seeing an early prototype.
- The clients have too much involvement which is not always aligned with the software developer.
- It does not appreciate too many modifications in the project as it easily disturbs the existing workflow of the entire software development process.
- Customers may not be satisfied or interested in the product after seeing the initial prototype.

6. Feature Driven Development



Feature Driven Development is an iterative software development methodology intended for use by large teams working on a project using object-oriented technology. This type of model is good for organizations that are transitioning from a phase-based approach to an iterative approach, this methodology also known as an **FDD** methodology.

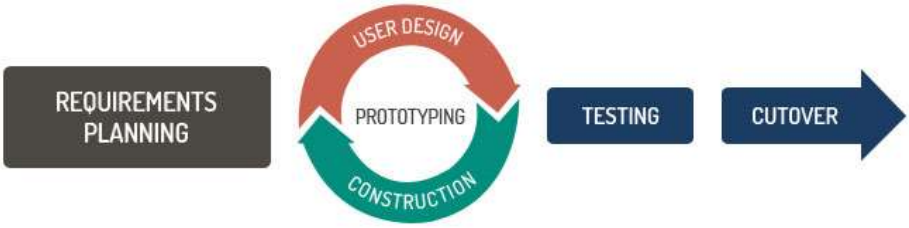
Advantages of FDD Methodology:

- With this model, Progress tracking of the project happens by a feature that is a focused approach.
- it allows multiple teams to work simultaneously. Which, in turn, reduces the time.
- FDD Helps to move larger size projects and obtain repeatable success.
- The simple five processes help to bring work done in a short time and easiest manner.
- This type of model is built on set standards for the software development industry, so it helps easy development and industry-recognized best practices.

Disadvantages of FDD Methodology:

- Not an ideal methodology for smaller projects, so it is not good for an individual software developer.
- High dependency on the main developer means the person should be fully equipped for an act as coordinator, lead designer, and mentor.
- No written documentation is provided to clients in this methodology, so they are not able to get proof for their software.

7. Rapid Application Development (RAD)



Rapid Application Development (RAD) is an effective methodology that provides much quicker development and higher-quality results than those achieved with the other software development methodologies. It is designed in such a way that it easily takes the maximum advantage of the software development. The main objective of this methodology is to accelerate the entire software development process. The goal is easily achievable because it allows active user participation in the development process.

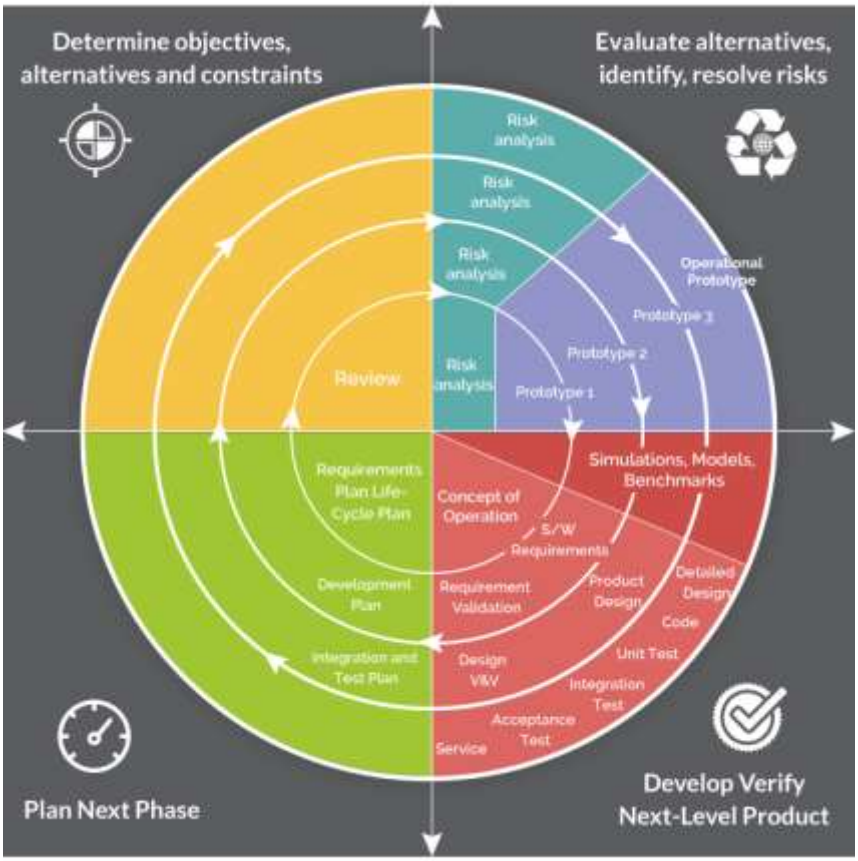
Advantages of the RAD model:

- Rapid Application development model helps to reduce the risk and required efforts on the part of the software developer.
- Additionally, this model also helps the clients to take quick reviews for the project.
- This methodology encourages customer feedback which always provides improvement scope for any software development project.
- As a result of prototyping in nature, there is a possibility of lesser defects.
- Each phase in RAD delivers the highest priority functionality to the client.

Disadvantages RAD model:

- This model depends on the strong team and individual performances for clearly identifying the exact requirement of the business.
- It only works on systems that can be modularized can be built using this methodology.
- This approach demands highly skilled developers and a designer's team which may not be possible for every organization.
- This method is not applicable for the developer to use in small budget projects as the cost of modeling and automated code generation is very high.
- Progress and problems accustomed are hard to track as such there is no documentation to demonstrate what has been done.

8. Spiral Model



The **Spiral Model** is a sophisticated model that focuses on the early identification and reduction of project risks. In this software development methodology, developers start on a small scale then explores the risks involved in the project, make a plan to handle the risks, and finally decides whether to take the next step of the project to do the next iteration of the spiral. The success of any Spiral Lifecycle Model depends on the reliable, attentive, and knowledgeable management of the project.

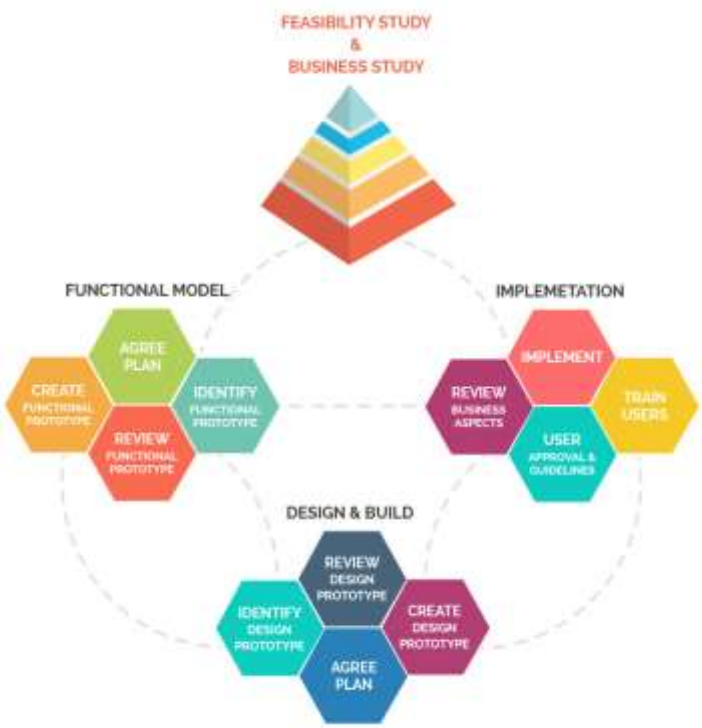
Advantages of Spiral Model:

- The high amount of risk analysis being done hence, avoidance of possible risk is certainly reduced with this model.
- This model is good for large size and critical projects.
- In the spiral model, additional functionality can be added at a later date.
- Development is fast and features are added systematically in this model.
- It is more suited for high-risk projects, where business needs may differ from time to time basis.

Disadvantages of Spiral Model:

- It is certainly a costly model to use in terms of development.
- The success of the entire project is dependent on the risk analysis phase thus, failure in this phase may damage the entire project.
- It is not appropriate for low-risk projects.
- The big risk of this methodology is that it may continue indefinitely and never finish.
- Documentation is more as it has intermediate phases.

8. Dynamic Systems Development Model Methodology



Dynamic Systems Development Model is a software development methodology originally based on the Rapid Application Development methodology. This is an iterative and incremental approach that emphasizes continuous user involvement. Its main aim is to deliver software systems on time and within budget. This model simply works on the philosophy that nothing is developed perfectly in the first attempt and considers it an ever-changing process.

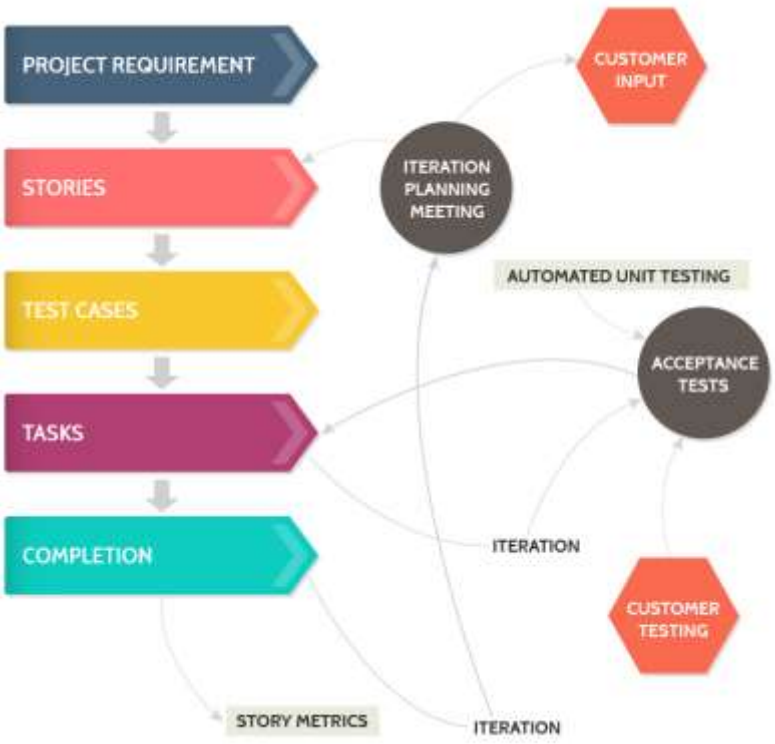
Advantages of Dynamic Systems Development Model:

- Users are highly involved in the development of the system so, they are more likely to get a grip on the software development project.
- In this model, the basic functionality is delivered quickly, with more functionality being delivered at frequent intervals.
- This method provides easy access by developers to end-users.
- In this kind of development, approach projects are delivered on time and within a specific budget.

Disadvantages of Dynamic Systems Development Model:

- The first thing is DSDM is costly to implement, as it requires users and developers both to be trained to employ it effectively. It may not be suitable for small organizations or one-time projects.
- It is a relatively new model, therefore, it is not very common and easy to understand.
- This model Requires significant user involvement.
- This model Involves the progressive development of requirements.

10. Extreme Programming Methodology



Extreme Programming is an agile software engineering methodology. This methodology, which is shortly known as XP methodology is mainly used for creating software within a very unstable environment. It allows greater flexibility within the modeling process. The main goal of this XP model is to lower the cost of software requirements. It is quite common in the XP model that the cost of changing the requirements at later stages in the project can be very high.

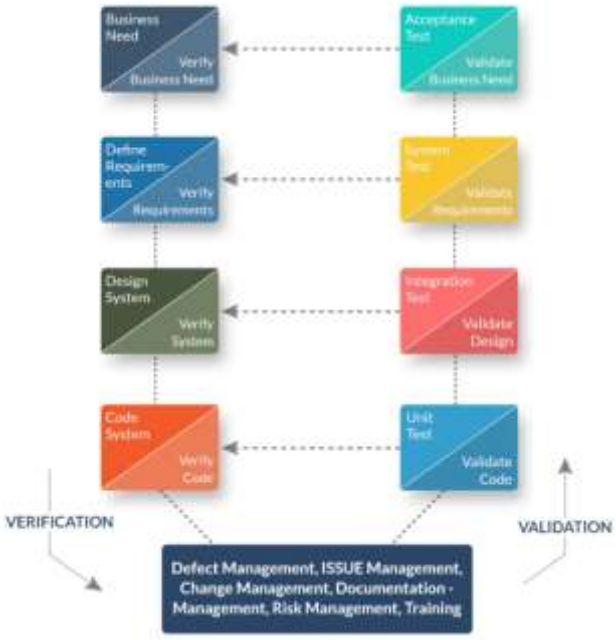
Advantages of Extreme Programming Methodology:

- The main advantage of Extreme Programming is that this methodology allows software development companies to save costs and time required for project realization. Time savings are available because of the fact that XP focuses on the timely delivery of final products. Extreme Programming teams save lots of money because they don't use too much documentation. They usually solve problems through discussions inside of the team.
- Extreme programming methodologies emphasize customer involvement.
- This model helps to establish rational plans and schedules and to get the developers personally committed to their schedules which are surely a big advantage in the XP model.
- This model is consistent with most modern development methods so, developers are able to produce quality software.

Disadvantages of Extreme Programming Methodology:

- Some specialists say that Extreme Programming is focused on the code rather than on design. That may be a problem because good design is extremely important for software applications. It helps sell them in the software market. Additionally, in XP projects the defect documentation is not always good. Lack of defect documentation may lead to the occurrence of similar bugs in the future.
- This methodology is only as effective as the people involved, Agile does not solve this issue.
- This kind of software development model requires meetings at frequent intervals at enormous expense to customers.
- It requires too many development changes which are very difficult to adopt every time for the software developer.
- In this methodology, it tends to impossible to be known exact estimates of work effort needed to provide a quote, because at the starting of the project nobody aware of the entire scope and requirements of the project.

11. Joint Application Development Methodology



Joint Application Development (JAD) is a requirements-definition and user-interface development methodology in which end-users, clients, and developers attend intense off-site meetings to work out and finalize software systems. This methodology aims to involve the client in the design and development of an application. JAD sessions easily accomplish targeted goals with a series of collaborative workshops. The main focus of this model is to resolve the business problem rather than technical details. Thus it is most suitable for developing business systems.

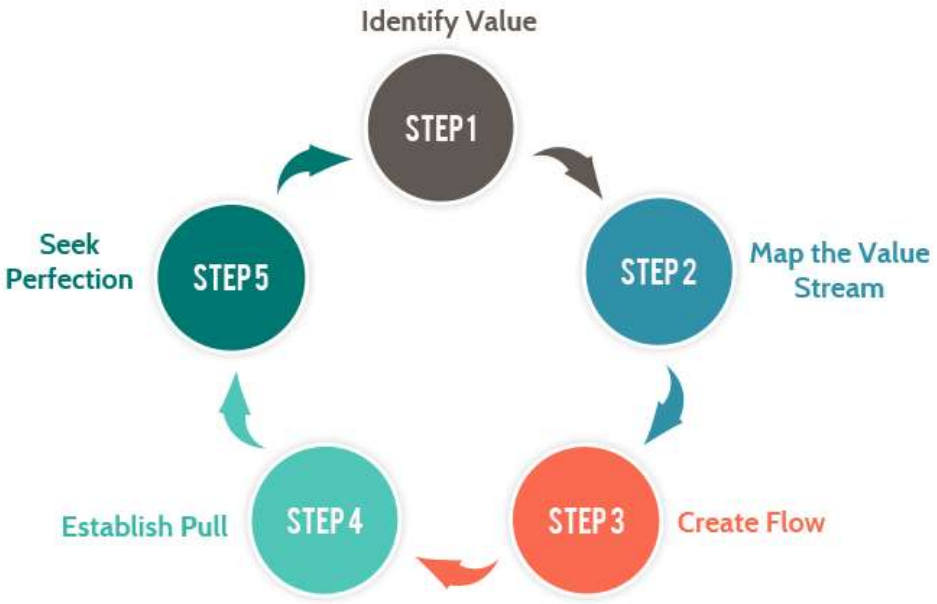
Advantages JAD Methodology:

- This methodology allows for the simultaneous gathering and consolidating of large amounts of information. The collaboration between the company and the clients lowers all risks.
- This software development mode effectively produces large amounts of high-quality information in a short period of time. It reduces the costs and time needed for project development.
- With the proper assistance of the organizer, the differences are immediately resolved in this method.
- This model provides a forum to explore multiple points of view regarding a topic.
- Well-defined requirements improve system quality.

Disadvantages of JAD Methodology:

- JAD methodology takes a large amount of time as it requires significant planning and scheduling effort on the part of the project development team.
- It requires significant investor commitment in terms of time and effort.
- This approach requires trained and experienced personnel for the effective implementation of the entire project.
- Different opinions within the team make it difficult to align goals and maintain focus.

12. Lean Development Methodology



Lean Development Methodology focuses on the creation of easily changeable software. This Software Development model is more strategically focused than any other type of agile methodology. The goal of this methodology is to develop software in one-third of the time, with a limited budget, and a very less amount of required workflow.

Advantages of Lean Development Methodology:

- The early elimination of the overall efficiency of the development process certainly helps to speeds up the process of entire software development which surely reduces the cost of the project.
- Delivering the product early is a definite advantage. It means that the development team can deliver more functionality in a shorter period of time, hence enabling more projects to be delivered.
- Empowerment of the development team helps in developing the decision-making ability of the team members which created more motivation among team members.

Disadvantages of Lean Development Methodology:

- Success in software development depends on how disciplined the team members are and how to advance their technical skills.
- The role of a business analyst is vital to ensure the business requirements documentation is understood properly. If any organization doesn't have a person with the right business analyst then this method may not be useful for them.
- In this development model, great flexibility is given to the developer which is surely great, but too much of it will quickly lead to a development team that lost focus on its original objectives thus, it hearts the flow of the entire project development work.

The above software development methodologies are very important which are mostly used for various software development projects. Moreover, all these methodologies work well in certain projects depending upon the nature of the project. It often happens that one methodology that is suited for a particular project may not be suited for another project. Moreover, none of these methodologies are fool proof as each has its pros and cons. So, software developers must have information about all these methodologies before selecting any of these development methods for their software development projects.

SYSTEM REQUIREMENTS[24]

To be used efficiently, all computer software needs certain hardware components or other software resources to be present on a computer. These prerequisites are known as (computer) **system requirements** and are often used as a guideline as opposed to an absolute rule. Most software defines two sets of system requirements: minimum and recommended. With increasing demand for higher processing power and resources in newer versions of software, system requirements tend to increase over time. Industry analysts suggest that this trend plays a bigger part in driving upgrades to existing computer systems than technological advancements. A second meaning of the term of system requirements, is a generalisation of this first definition, giving the requirements to be met in the design of a system or sub-system.

[24] https://techterms.com/definition/system_requirements

Often manufacturers of games will provide the consumer with a set of requirements that are different from those that are needed to run software. These requirements are usually called the recommended requirements. These requirements are almost always of a significantly higher level than the minimum requirements, and represent the ideal situation in which to run the software. Generally speaking, this is a better guideline than minimum system requirements in order to have a fully usable and enjoyable experience with that software.

Hardware Requirements. The most common set of requirements defined by any operating system or software application is the physical computer resources, also known as hardware, A hardware requirements list is often accompanied by a hardware compatibility list (HCL), especially in case of operating systems. An HCL lists tested, compatible, and sometimes incompatible hardware devices for a particular operating system or application. The following sub-sections discuss the various aspects of hardware requirements.

Software Requirements deal with defining software resource requirements and prerequisites that need to be installed on a computer to provide optimal functioning of an application. These requirements or prerequisites are generally not included in the software installation package and need to be installed separately before the software is installed.

System Requirements	
Operating system	Windows 8.1 64 Bit, Windows 8 64 Bit, Windows 7 64 Bit Service Pack 1, Windows Vista 64 Bit Service Pack 2
CPU	Core 2 Quad Q6600 at 2.4 GHz or AMD Phenom 9850 at 2.5 GHz
Memory	4 GB RAM
Free space	65 GB of free space
Graphics hardware	DirectX 10-compatible GPU: GeForce 9800GT 1GB or ATI Radeon HD 4870 1GB
Sound hardware	DirectX 10 compatible sound card

PERFORMANCE TASK 4

Prepare and submit your Chapter 3.

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Chapter 3

RESEARCH DESIGN

This chapter presents the methods and procedures used in this study. It includes the sources of data, data gathering procedures, software development methodology, and the system requirements of the study.

Research Method

A world-class university producing leaders and change agents for social transformation and development. A world-class university producing leaders and change agents for social transformation and development (Author, Year). A world-class university producing leaders and change agents for social transformation and development.

Sources of Data

A world-class university producing leaders and change agents for social transformation and development. A world-class university producing leaders and change agents for social transformation and development (Author, Year). A world-class university producing leaders and change agents for social transformation and development.

The Bicol University shall give professional and technical training and provide advanced and specialized instruction in literature, philosophy, the sciences and arts, besides providing for the promotion of scientific and technological researches. The Bicol University shall give professional and technical training and provide advanced and specialized instruction in literature, philosophy, the sciences and arts, besides providing for the promotion of scientific and technological researches (Author, Year).

Data Gathering Procedures

A world-class university producing leaders and change agents for social transformation and development. A world-class university producing leaders and change agents for social transformation and development (Author, Year). A world-class university producing leaders and change agents for social transformation and development.

The Bicol University shall give professional and technical training and provide advanced and specialized instruction in literature, philosophy, the sciences and arts, besides providing for the promotion of scientific and technological researches. The Bicol University shall give professional and technical training and provide advanced and specialized instruction in literature, philosophy, the sciences and arts, besides providing for the promotion of scientific and technological researches (Author, Year).

Software Development Methodology

A world-class university producing leaders and change agents for social transformation and development. A world-class university producing leaders and change agents for social transformation and development (Author, Year). A world-class university producing leaders and change agents for social transformation and development.

The Bicol University shall give professional and technical training and provide advanced and specialized instruction in literature, philosophy, the sciences and arts, besides providing for the promotion of scientific and technological researches. The Bicol University shall give professional and technical training and provide advanced and specialized instruction in literature, philosophy, the sciences and arts, besides providing for the promotion of scientific and technological researches (Author, Year).

Figure 2. SDLC

System Requirements

A world-class university producing leaders and change agents for social transformation and development. A world-class university producing leaders and change agents for social transformation and development (Author, Year). A world-class university producing leaders and change agents for social transformation and development.

The Bicol University shall give professional and technical training and provide advanced and specialized instruction in literature, philosophy, the sciences and arts, besides providing for the promotion of scientific and technological researches. The Bicol University shall give professional and technical training and provide advanced and specialized instruction in literature, philosophy, the sciences and arts, besides providing for the promotion of scientific and technological researches (Author, Year).

Figure 3. System Requirements

REFERENCES

Use APA 6 Format

McKenzie, H., Boughton, M., Hayes, L., & Forsyth, S. (2008). Explaining the complexities and value of nursing practice and knowledge. In I. Morley & M. Crouch (Eds.), *Knowledge as value: Illumination through critical prisms* (pp. 209-224). Amsterdam, Netherlands: Rodopi.

STUDY GUIDE

5 WRITING THE COMPONENTS OF CHAPTER 4

INTENDED LEARNING OUTCOMES

At the end of this lesson, the student is expected to:

- Describe the data collection techniques;
- Discuss the findings in the light of previous research findings and literature, where applicable, in order to identify similarities and differences between this study and previous studies and literature;
- Present the results and analysis of the proposed study; and
- Support the presentation with tables, graphs, charts and figures where applicable.

DATA ANALYSIS AND FINDINGS[1]

Data analysis is the most crucial part of any research. Data analysis summarizes collected data. It involves the interpretation of data gathered through the use of analytical and logical reasoning to determine patterns, relationships or trends.

Tips:

1. Use more datasets and sample
2. Do not delegate your data analysis
3. Keep in mind who will be reading your results and present it in a way that they will understand it.

RESEARCH DATA[2]

Research data, unlike other types of information, is collected, observed, or created, for purposes of analysis to produce original research results. Managing data is an integral part of the research process. It can be challenging particularly when studies involve several researchers and/or when studies are conducted from multiple locations. How data is managed depends on the types of data involved, how data is collected and stored, and how it is used – throughout the research lifecycle.

[1] https://up-za.libguides.com/c.php?g=485435&p=4425510
[2] https://up-za.libguides.com/c.php?g=356288&p=2420371

EVALUATION TOOLS

ISO/IEC 25010[3]

The quality model is the cornerstone of a product quality evaluation system. The quality model determines which quality characteristics will be taken into account when evaluating the properties of a software product.

The quality of a system is the degree to which the system satisfies the stated and implied needs of its various stakeholders, and thus provides value. Those stakeholders' needs (functionality, performance, security, maintainability, etc.) are precisely what is represented in the quality model, which categorizes the product quality into characteristics and sub-characteristics.

The product quality model defined in ISO/IEC 25010 comprises the eight quality characteristics shown in the following figure:

Functional Suitability

This characteristic represents the degree to which a product or system provides functions that meet stated and implied needs when used under specified conditions. This characteristic is composed of the following sub-characteristics:

Functional completeness - Degree to which the set of functions covers all the specified tasks and user objectives.

Functional correctness - Degree to which a product or system provides the correct results with the needed degree of precision.

Functional appropriateness - Degree to which the functions facilitate the accomplishment of specified tasks and objectives.

[3] https://iso25000.com/index.php/en/iso-25000-standards/iso-25010

Performance efficiency

This characteristic represents the performance relative to the amount of resources used under stated conditions. This characteristic is composed of the following sub-characteristics:

Time behaviour - Degree to which the response and processing times and throughput rates of a product or system, when performing its functions, meet requirements.

Resource utilization - Degree to which the amounts and types of resources used by a product or system, when performing its functions, meet requirements.

Capacity - Degree to which the maximum limits of a product or system parameter meet requirements.

Compatibility

Degree to which a product, system or component can exchange information with other products, systems or components, and/or perform its required functions while sharing the same hardware or software environment. This characteristic is composed of the following sub-characteristics:

Co-existence - Degree to which a product can perform its required functions efficiently while sharing a common environment and resources with other products, without detrimental impact on any other product.

Interoperability - Degree to which two or more systems, products or components can exchange information and use the information that has been exchanged.

Usability

Degree to which a product or system can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use. This characteristic is composed of the following sub-characteristics:

Appropriateness recognizability - Degree to which users can recognize whether a product or system is appropriate for their needs.

Learnability - Degree to which a product or system can be used by specified users to achieve specified goals of learning to use the product or system with effectiveness, efficiency, freedom from risk and satisfaction in a specified context of use.

Operability - Degree to which a product or system has attributes that make it easy to operate and control.

User error protection. Degree to which a system protects users against making errors.

User interface aesthetics - Degree to which a user interface enables pleasing and satisfying interaction for the user.

Accessibility - Degree to which a product or system can be used by people with the widest range of characteristics and capabilities to achieve a specified goal in a specified context of use.

Reliability

Degree to which a system, product or component performs specified functions under specified conditions for a specified period of time. This characteristic is composed of the following sub-characteristics:

Maturity - Degree to which a system, product or component meets needs for reliability under normal operation.

Availability - Degree to which a system, product or component is operational and accessible when required for use.

Fault tolerance - Degree to which a system, product or component operates as intended despite the presence of hardware or software faults.

Recoverability - Degree to which, in the event of an interruption or a failure, a product or system can recover the data directly affected and re-establish the desired state of the system.

Security

Degree to which a product or system protects information and data so that persons or other products or systems have the degree of data access appropriate to their types and levels of authorization. This characteristic is composed of the following sub-characteristics:

Confidentiality - Degree to which a product or system ensures that data are accessible only to those authorized to have access.

Integrity - Degree to which a system, product or component prevents unauthorized access to, or modification of, computer programs or data.

Non-repudiation - Degree to which actions or events can be proven to have taken place so that the events or actions cannot be repudiated later.

Accountability - Degree to which the actions of an entity can be traced uniquely to the entity.

Authenticity - Degree to which the identity of a subject or resource can be proved to be the one claimed.

Maintainability

This characteristic represents the degree of effectiveness and efficiency with which a product or system can be modified to improve it, correct it or adapt it to changes in environment, and in requirements. This characteristic is composed of the following sub-characteristics:

Modularity - Degree to which a system or computer program is composed of discrete components such that a change to one component has minimal impact on other components.

Reusability - Degree to which an asset can be used in more than one system, or in building other assets.

Analysability - Degree of effectiveness and efficiency with which it is possible to assess the impact on a product or system of an intended change to one or more of its parts,

or to diagnose a product for deficiencies or causes of failures, or to identify parts to be modified.

Modifiability - Degree to which a product or system can be effectively and efficiently modified without introducing defects or degrading existing product quality.

Testability - Degree of effectiveness and efficiency with which test criteria can be established for a system, product or component and tests can be performed to determine whether those criteria have been met.

Portability

Degree of effectiveness and efficiency with which a system, product or component can be transferred from one hardware, software or other operational or usage environment to another. This characteristic is composed of the following sub-characteristics:

Adaptability - Degree to which a product or system can effectively and efficiently be adapted for different or evolving hardware, software or other operational or usage environments.

Installability - Degree of effectiveness and efficiency with which a product or system can be successfully installed and/or uninstalled in a specified environment.

Replaceability - Degree to which a product can replace another specified software product for the same purpose in the same environment.

PERFORMANCE TASK 5

Prepare and submit your Chapter 4.

_____
_____
_____
_____.

DATA REQUIREMENTS *(Objective no. 1)*

_____
_____
_____
_____.

PROPOSED SYSTEM *(Objective no. 2)*

_____
_____
_____
_____.

EVALUATION RESULTS *(Objective no. 3)*

_____
_____
_____
_____.

Sample Format

Chapter 4

DATA ANALYSIS AND INTERPRETATION

This chapter presents the existing policies and procedures, proposed system or mobile application, and the evaluation result of the study.

Data Requirements (Objective No. 1)

A world-class university producing leaders and change agents for social transformation and development. A world-class university producing leaders and change agents for social transformation and development (Author, Year). A world-class university producing leaders and change agents for social transformation and development.

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Proposed System (Objective No. 2)

A world-class university producing leaders and change agents for social transformation and development. A world-class university producing leaders and change agents for social transformation and development (Author, Year). A world-class university producing leaders and change agents for social transformation and development.

Figure 4. System Output/Design

Evaluation Results (Objective No. 3)

A world-class university producing leaders and change agents for social transformation and development. A world-class university producing leaders and change agents for social transformation and development (Author, Year). A world-class university producing leaders and change agents for social transformation and development.

The Bicol University shall give professional and technical training and provide advanced and specialized instruction in literature, philosophy, the sciences and arts, besides providing for the promotion of scientific and technological researches. The Bicol University shall give professional and technical training and provide advanced and specialized instruction in literature, philosophy, the sciences and arts, besides providing for the promotion of scientific and technological researches (Author, Year).

Table 1. Name of the table in Times New Roman, size 12, regular, left aligned

Column 1	Column 2*	Column 3
First row column 1 entry	First row column 2 entry	First row column 3 entry
Second row column 1 entry	Second row column 2 entry	Second row column 3 entry
Third row column 1 entry	Third row column 2 entry	Third row column 3 entry
Fourth row column 1 entry	Fourth row column 2 entry	Fourth row column 3 entry

**Column 2 legend*

REFERENCES

Use APA 6 Format

McKenzie, H., Boughton, M., Hayes, L., & Forsyth, S. (2008). Explaining the complexities and value of nursing practice and knowledge. In I. Morley & M. Crouch (Eds.), *Knowledge as value: Illumination through critical prisms* (pp. 209-224). Amsterdam, Netherlands: Rodopi.

STUDY GUIDE

6 WRITING THE COMPONENTS OF CHAPTER 5

INTENDED LEARNING OUTCOMES

At the end of this lesson, the student is expected to:

- Present, discuss, and interpret the summary of findings;
- Discuss the conclusion of the study, and
- Present the recommendations

SUMMARY OF FINDINGS[1]

Data analysis is the most crucial part of any research. Data analysis summarizes collected data. It involves the interpretation of data gathered through the use of analytical and logical reasoning to determine patterns, relationships or trends. Write a paragraph or two of discussion for each finding in your study. Assert the findings. Tell the reader how the finding is important or relevant to your studies aim and focus. Compare your findings to the literature.

CONCLUSION AND RECOMMENDATION[2]

Conclusions interpret the findings or results of an investigation. Recommendations follow conclusions and are opinions supported by the report's findings. The Conclusions and Recommendations may be combined or, in long reports, presented in separate sections. The Conclusions section sums up the key points of your discussion, the essential features of your design, or the significant outcomes of your investigation. As its function is to round off the story of your project, it should:

- be written to relate directly to the aims of the project as stated in the Introduction
- indicate the extent to which the aims have been achieved
- summarise the key findings, outcomes or information in your report
- acknowledge limitations and make recommendations for future work (where applicable)
- highlight the significance or usefulness of your work.

For recommendations, always address limitations and suggest how they might be overcome in future work.

[1] https://getitglossary.org/term/summary+of+findings
[2] https://www.monash.edu/rlo/assignment-samples/engineering/eng-writing-technical-reports/conclusions-and-recommendations

PERFORMANCE TASK 6

Prepare and submit your Chapter 54.

_____
_____
_____
_____.

Sample Format

Chapter 5

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

This chapter presents the summary of findings, conclusion and recommendations of the study.

Summary of Findings

A world-class university producing leaders and change agents for social transformation and development. A world-class university producing leaders and change agents for social transformation and development (Author, Year). A world-class university producing leaders and change agents for social transformation and development.

The Bicol University shall give professional and technical training and provide advanced and specialized instruction in literature, philosophy, the sciences and arts, besides providing for the promotion of scientific and technological researches. The Bicol University shall give professional and technical training and provide advanced and specialized instruction in literature, philosophy, the sciences and arts, besides providing for the promotion of scientific and technological researches (Author, Year).

1. A world-class university producing leaders and change agents for social transformation and development.
2. A world-class university producing leaders and change agents for social transformation and development.
3. A world-class university producing leaders and change agents for social transformation and development.

Conclusions

A world-class university producing leaders and change agents for social transformation and development. A world-class university producing leaders and change agents for social transformation and development (Author, Year). A world-class university producing leaders and change agents for social transformation and development.

1. A world-class university producing leaders and change agents for social transformation and development.
2. A world-class university producing leaders and change agents for social transformation and development.
3. A world-class university producing leaders and change agents for social transformation and development.

Recommendations

A world-class university producing leaders and change agents for social transformation and development. A world-class university producing leaders and change agents for social transformation and development (Author, Year). A world-class university producing leaders and change agents for social transformation and development.

1. A world-class university producing leaders and change agents for social transformation and development.
2. A world-class university producing leaders and change agents for social transformation and development.
3. A world-class university producing leaders and change agents for social transformation and development.

REFERENCES

Use APA 6 Format

McKenzie, H., Boughton, M., Hayes, L., & Forsyth, S. (2008). Explaining the complexities and value of nursing practice and knowledge. In I. Morley & M. Crouch (Eds.), *Knowledge as value: Illumination through critical prisms* (pp. 209-224). Amsterdam, Netherlands: Rodopi.

STUDY GUIDE

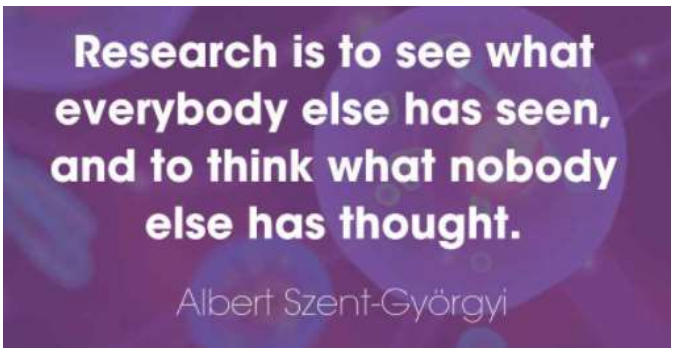
7 WRITING THE COMPONENTS OF THESIS BRIEF

INTENDED LEARNING OUTCOMES

At the end of this lesson, the student is expected to:

- Present and discuss the components of IMRAD and
- Present the thesis brief format

THE IMRaD FORMAT



What is the IMRaD Format?

The IMRaD (often pronounced “im-rad”)

Four or Five major sections:
Introduction (I);
Research Methods (M);
Results (R);
Analysis (a); and
Discussion (D).

The IMRaD format is the most commonly used format in scientific article and journal writing and is used widely across most scientific and research fields.

When Do I Use the IMRaD Format?

If you are writing a paper where you are conducting objective research in order to answer a specific question, the IMRaD format will most likely serve your purposes best.

The IMRaD format is especially useful if you are conducting primary research (such as experimentation, questionnaires, focus groups, observations, interviews, and so forth), but it can be applied even if you only conduct secondary research (which is research you gather from reading sources like books, magazines, journal articles, and so forth.)

The goal of using the IMRaD format is to present facts objectively, demonstrating a genuine interest and care in developing new understanding about a topic; when using this format, you don't explicitly state an argument or opinion, but rather, you rely on collected data and previously researched information in order to make a claim.

While there are nuances and adjustments that would be made to the following document types, the IMRaD format is the foundational structure many research-driven documents:

- Grants
- Proposals
- Recommendation reports
- Project management plans or
- Thesis

How Does the IMRaD Format Work?

As mentioned above, the IMRaD format includes four or five major sections. The small letter "a" has had multiple interpretations over the years; some would suggest it means nothing other than "and," as in "Introduction, Methods, Results, ***and*** Discussion," but others have argued that the "a" should be viewed as "Analysis" in papers where the "Results" section may not be immediately clear and a section that analyzes the results is important for reader comprehension.

Either way, the "a" often remains in lower-case to indicate that, while it's often important, it isn't always necessary.

Then let's review the five major sections, with "a" given equal weight to the other sections.

Note that these five sections should ***always*** go in the order listed:

1. **Introduction:** The introduction states the research problem or the question(s) you intend to address through research. Your introduction would typically include some variation of the following:
   - Statement of the topic you are about to address
   - Current state of the field of understanding (often, we call this a literature review and it may even merit having its own section)
   - Problem or gap in knowledge (what don't we know yet or need to know? what does the field still need to understand? what's been left out of previous research? is this a new issue that needs some direction?)
   - Forecast statement that explains, very briefly, what the rest of the paper will entail, including a possible quick explanation of the type of research that needs to be conducted

2. **Methods:** The research methods section can go any number of different directions, depending on the type of research you conducted. Regardless of what you did for your research, though, this section needs to be very clear, very specific, very detailed, and only focused on ***research*.**

Avoid explaining what the research means– because this is for the next sections, Analysis and Discussion. While the research section is often considered the most boring section for someone to read, it is also considered the most important section to build your credibility. If your research methods are sound, your paper holds a lot more weight.

Here are few tips to make your methods section work well:

- Separate each type of research you conducted (interviews, focus groups, experiments, etc.) into sub-sections and only discuss one research method in each sub-section (for clarity and organization, it's important to not talk about multiple methods at once)
- Be very detailed about your process. If you interviewed people, for example, we need to know how many people you interviewed, what you asked them, what you hoped to learn by interviewing them, why chose to interview over other methods, why you interviewed those people specifically (including providing they demographic information if it's relevant), and so forth. For other types of data collection, we need to know what your methods were–how long you observed; how frequently you tested; how you coded qualitative data; and so forth.
- Don't discuss what the research means. You'll use the next two sections–again to Analysis and Discussion–to talk about what the research means. To stay organized, simply discuss your research methods. This is the single biggest mistake when writing research papers, so don't fall into that trap.

3. **Results:** The results section is critical for your audience to understand what the research showed. Use this section to show tables, charts, graphs, quotes, etc. from your research. At this point, you are building your reader towards drawn conclusions, but you are not yet providing a full analysis. You're simply showing what the data says. Follow the same order as the Methods section–if you put interviews first, then focus groups second, do the same in this section. Be sure, when you include graphics and images, that you label and title every table or graphic

For example ("**Table 3: you label it Interview Results**") and that you introduce them in the body of your text, like ("As you can see in **Table 3**, seventy-nine percent of respondents…")

4. **Analysis:** The analysis section details what you and others may learn from the data.

While some researchers like to combine this section with the Discussion section, many writers and researchers find it useful to analyze the data separately. In the analysis section, spend time connecting the dots for the reader. What do the interviews say about the way employers think about their employees? What do the observations say about how employees respond to workplace criticism? Can any connections be made between the two research types?

It's important in the Analysis section that you don't draw conclusions that the research findings don't suggest. ***Always*** stick to what the research says.

5. **Discussion:** Finally, for discussion, you conclude this paper by suggesting what new knowledge this provides to the field.

You'll often want to note the limitations of your study and what further research still needs to be done. If something alarming or important was discovered, this is where you highlight that information.

If you use the IMRaD format to write other types of papers (like a recommendation report or a plan), this is where you put the recommendations or the detailed plan.

PERFORMANCE TASK 7

Prepare and submit your Thesis Brief.

_____
_____
_____
_____.

Sample Format

Thesis brief format for the 16th Student R&D Forum

(The title is typed in bold, font size 14 pt., Times New Roman. Do not capitalize words in the title except the first word of the title or proper nouns. Title should be in inverted triangle format. Between title and name of authors, there is a single space.).

Maria Aurea B. Guiriba[1] and **Gremil Alessandro A. Naz**[2]
[1]BU Research Development and Management Division
[2]BU Center for Policy Studies and Development
(The authors are listed in one paragraph in Times New Roman font size 10 pt. bold. Use superscripts if authors have different affiliations. Affiliations are written in font size 10 pt. Different affiliations are put in separate paragraphs and numbered with the superscripted numbers used in the authors list.

Keywords: *16th BUBUT abstract, BU Student R&D Forum (Maximum of five keywords)*

Abstract

The abstract should provide a brief introduction to the problem and the objectives. A statement regarding the methodology should generally be followed with a brief summary of results. The abstract should end with the significance of the results, as well as a brief conclusion and recommendation. The abstract shall not exceed 250 words.

Introduction

The introduction should include the general rationale, statement of objectives, and scope of the study. It shall end with the articulation of the significance of the study.

Materials and Methods

This shall include the basic description of the locale or the population or community of concern. Research designs, strategies, and methodologies shall be briefly discussed. Data processing strategies (statistics used, if there are any), as well as the interpretation and limitation of results shall be outlined here as well.

Results and Discussions

The results and discussion section should occupy the main portion of the extended abstract. It must contain the findings of the research.

Illustrations, photographs and tables should be formatted according to the following guides: (1) Figures, photographs, and tables should be integrated with the text. (2) Captions of tables should be at the top of each table. (3) Captions of figures should be at the bottom of each figure. (4) Extremely small fonts or those below size 10, should be avoided. (5) Legends and text, if any, should be integrated in the tables and figures. (6) Captions of figures and tables should be in italics.

Only SI units and abbreviations should be used. Abbreviations should be explained when they first appear in the text. If a non-standard abbreviation is to be used extensively, it should be defined in full at the beginning of the text. For mineral contents, the elements (P, N,

K, etc.) should be used. Isotopes should be mentioned as 14 C, 32 P, etc. Ions should be mentioned as H^+, Mg^{2+}, etc. Latin biological names should be italicized.

Conclusions

The conclusions must be based on the objectives of the study. They should be supported by the findings of the study. Present conclusions in narrative format.

Recommendations

Provide only recommendations that can be supported by the findings of the study. Present recommendations in narrative format.

References

Referencing of the citations shall be in alphabetical order, following APA format, and mentioning the author and year of publication. In case of two authors, both should be mentioned and presented either as (García & López, 2006) or García and López (2006). If several papers by the same author in the same year are cited, they should be lettered in sequence (2000a, 2000b). When papers are authored by more than two authors, they should be cited either as (López et al., 2006) or Lopez et al. (2006). Referencing of materials shall follow the samples below:

Journal articles

Naz, G.A.A. (2021). The role of information technology in managing the conflicts of long-distance partners: The case of Filipino migrant workers. *International Journal of Sociotechnology and Knowledge Development, 13*(1), 65-78. http://doi.org/10.4018/IJSKD.2021010106

Books

Shotton, M.A. (1989). *Computer addiction? A study of computer dependency*. Taylor & Francis.

Book chapters

Haybron, D.M. (2008). Philosophy and the science of subjective well-being. In M. Eid & R.J. Larsen (Eds.), *The science of subjective well-being* (pp. 17-43). Guilford Press.

For more information about the APA (7th ed.) format, please go to https://libguides.csudh.edu/citation/apa-7 or other resources available online.

General Instructions in preparing the thesis brief

- Papers should ***not exceed 20 pages***, including references, tables, and illustrations.
- Margin must be 1 inch on all sides, using A4-size paper.
- Font for the whole document is 12 pt. **Times New Roman**. Text paragraphs are left and right justified. Headings should be 12 pt. **Times New Roman bold.**

Guidelines for Poster Presentation & Exhibits

The primary purpose of a poster is to provide visual communication of information and ideas. With the poster presentation, viewers must be able to understand the gist of the research output. Viewers appreciate being able to take a quick walk among a large number of posters and then return to the displays that are of greatest interest to them. Posters must be simple yet informative, understandable, readable, organized, and attractive.

The following guidelines shall be observed in the preparation of posters:

A. *Format/Physical Features*
   i. Size: 36" x 48" (3 ft x 4 feet)
   ii. Orientation: Portrait layout
   iii. Material: Submit an e-copy rendered in the required size
   iv. Color mix: Shall fit to a light display background
   v. Content layout: Freestyle

B. *General Content*
   i. Title, Researcher/s, and Institutional Affiliation
   ii. Introduction
   iii. Materials and Methods
   iv. Results and Discussion
   v. Conclusions and Recommendations
   vi. References and Acknowledgement

C. *Title of Poster*
   i. The title must be written in upper case (except for scientific names which shall follow the conventional format).
   ii. Font size for the main title is not less than 72 and not less than 40 for the subtitle, if any.
   iii. On the main title, a footnote must indicate that the poster is showcased for the particular event with the venue and date.
   iv. The size of the footnote should be legible at one (1) meter distance.

D. *Author's Name*
   i. The name of the author/s must be complete, written in upper case.
   ii. The first letters of the important words in the author/s' institutional affiliation and address must be written in uppercase. The author/s' institutional affiliation and address should be italicized.
   iii. The font size of the author's name and affiliation is 30.

E. *Text*
   i. The text must be readable within a two-meter distance and printed preferably using font size 30.
   ii. Use of two or more colors. Good color combinations are black on white background or dark text on a light background because it is easy to read.
   iii. The introduction should be brief but must be enough to include the basic rationale, objectives, and significance of the research work.
   iv. The materials and methods should enumerate key approaches and contain a basic description of methodologies.
   v. Results and discussion should directly respond to the objectives.
   vi. Conclusions and recommendations should be enumerated according to the order of priority.
   vii. Cite only very important references in font size 18.

F. Illustrations, Tables, Graphs, and Photographs

i. Any figure or table must have a minimum size of 5" x 7" (12.5 cm x 18 cm).
ii. Labels and captions for tables must be written at the upper center of the table, while in figures, they should be at the bottom center. These captions or labels should be readable within two (2) meters.
iii. Ensure clarity of illustration and tables. Include short tables when necessary. Self-explanatory graphics should dominate the poster. Use minimal amount of text to supplement the graphic materials. Use of graphics as text background is discouraged as they diminish the readability of the poster.
iv. Use empty spaces between poster elements to differentiate and accentuate these elements.
v. Use of 2 to 3 colors for emphasis is valuable; overuse is not.

BIBLIOGRAPHY

Books

Bachani, A. M., Peden, M., Gururaj, G., Norton, R., & Hyder, A. A. (2017). Chapter 3 Road Traffic Injuries. In C. Mock, R. Nugent, & O. Kobusingye, *Injury Prevention and Environmental Health, 3rd edition.* Washington DC: The International Bank for Reconstruction and Development. Retrieved from https://www.ncbi.nlm.nih.gov/books/NBK525212/

Journal

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APPENDICES

Appendix A

Republic of the Philippines
OFFICE OF THE PRESIDENT
COMMISSION ON HIGHER EDUCATION

CHED MEMORANDUM ORDER (CMO)
NO. 25 ;
Series of 2015

SUBJECT : REVISED POLICIES, STANDARDS, AND GUIDELINES FOR BACHELOR OF SCIENCE IN COMPUTER SCIENCE (BSCS), BACHELOR OF SCIENCE IN INFORMATION SYSTEMS (BSIS), AND BACHELOR OF SCIENCE IN INFORMATION TECHNOLOGY (BSIT) PROGRAMS

In accordance with the pertinent provisions of Republic Act (RA) No. 7722, otherwise known as the "*Higher Education Act of 1994*," in pursuance of an outcomes-based quality assurance system as advocated under CMO 46 s. 2012, and by virtue of the Commission en banc Resolution No. 268-2015 dated May 25, 2015 the following policies, standards and guidelines (PSGs) are hereby adopted and promulgated by the Commission.

ARTICLE I
INTRODUCTION

Section 1 Rationale

Based on the Guidelines for the Implementation of CMO 46 s 2012, this PSG implements the "shift to learning competency-based standards/outcomes-based education." It specifies the 'core competencies' expected of graduates of *Bachelor of Science in Computer Science (BSCS), Bachelor of Science in Information Systems (BSIS), and Bachelor of Science in Information Technology (BSIT)*, "regardless of the type of HEI they graduate from." However, in "recognition of the spirit of outcomes-based education and ... of the typology of HEIs," this PSG also provides "ample space for HEIs to innovate in the curriculum in line with the assessment of how best to achieve learning outcomes in their particular contexts and their respective missions ..."

The field of computing is ever dynamic; its advancement and development had been rapid and its evolvement is a continuous process (O'Brien, 2008). To face the challenges of advancement, the Commission recognizes the need to be responsive to the current needs of the country. It is essential and important that the country's computing capability be continually developed and strengthened to be at par globally.

It is the objective of the Commission to develop and promote the Policies, Standards and Guidelines (PSG) for BSCS, BSIS and BSIT, to provide a minimum standard for Higher Education Institutions (HEIs) offering or intending to offer these programs. The PSG is developed with consultations from all stakeholders, from the academe to industry (Sarmiento, 2009).

The PSG contains provisions that cultivate the culture of excellence in offering these programs. This is in line with the vision of the Commission to have HEIs produce competent graduates that shall cater to the needs of the industry. The PSG is also designed for all HEIs to exercise their innovativeness and creativity in the development of their curricula in the offering of BSCS, BSIS, and BSIT programs (RA 7722, 1994).

Higher Education Development Center Building, C.P. Garcia Ave., UP Campus, Diliman, Quezon City, Philippines
Web Site: www.ched.gov.ph Tel. Nos. 441-1177, 385-4391, 441-1169, 441-1149, 441-1170, 441-1216, 392-5296

ARTICLE II
AUTHORITY TO OPERATE

Section 2 Government Recognition

All Higher Education Institutions (HEIs) including private HEIs, State Universities and Colleges (SUCs), and Local Universities and Colleges (LUCs) intending to offer BSCS, BSIS, and BSIT must first secure proper authority from the Commission in accordance with this PSG. All HEIs with existing BSCS, BSIS, and/or BSIT programs are required to shift to outcomes-based approach pursuant to this PSG and must inform the Commission of such shift. SUCs and LUCs should likewise strictly adhere to the provisions in these policies, standards and guidelines.

ARTICLE III
GENERAL PROVISIONS

Section 3 The succeeding articles provide minimum standards and other requirements and prescriptions. The minimum standards for each program are expressed as minimum sets of desired program outcomes which are given in Article IV Section 6. The Commission designed **sample** curricula to attain such outcomes and these are shown in Article V Section 9. The total number of units for each program is here prescribed as the "minimum unit requirement" under Section 13 of RA 7722. In designing the curricula, the Commission employed curriculum maps which are shown in Article V Section 10 as **sample** curriculum map.

Using a learner-centered/outcomes-based approach, the Commission provided sample curricula delivery methods shown in Article V Section 11. The sample course syllabi given in Article V Section 12 show some of these methods.

Based on the curricula and the means of their delivery, the Commission determined the physical resource requirements for the library, laboratories and other facilities and the human resource requirements in terms of administration and faculty, as indicated in Article VI.

Section 4 The HEIs are allowed to design curricula suited to their own contexts and missions provided that they can demonstrate that the same leads to the attainment of the required minimum set of outcomes, albeit by a different route. In the same vein, they have latitude in terms of curriculum delivery and in terms of specification and deployment of human and physical resources as long as they can show that the attainment of the program outcomes and satisfaction of program educational objectives can be assured by the alternative means they propose.

The HEIs can use the **CHED Implementation Handbook for Outcomes-Based Education (OBE) and the Institutional Sustainability Assessment (ISA)** as a guide in complying with Sections 16, 17 and 22 of Article VII, hereof.

This PSG is based on the 10-year basic education system and on the existing General Education (GE) program. It reflects the reform towards outcomes-based education as well as international trends in computer science, information systems and information technology curricula. However, this does not yet include necessary changes as a consequence of the K-12 reform. The latter shall be addressed subsequently.

ARTICLE IV
PROGRAM SPECIFICATIONS

Section 5 Program Description

5.1 Degree Name

A. Bachelor of Science in Computer Science (BSCS)

Graduates of this program shall be conferred the degree of **Bachelor of Science in Computer Science (BSCS).**

B. Bachelor of Science in Information Systems (BSIS)

Graduates of this program shall be conferred the degree of **Bachelor of Science in Information Systems (BSIS).**

C. Bachelor of Science in Information Technology (BSIT)

Graduates of this program shall be conferred the degree of **Bachelor of Science in Information Technology (BSIT).**

5.2 Nature of the Field of Study

5.2.1 Bachelor of Science in Computer Science (BSCS)

The BS Computer Science program includes the study of computing concepts and theories, algorithmic foundations and new developments in computing. The program prepares students to design and create algorithmically complex software and develop new and effective algorithms for solving computing problems.

The program also includes the study of the standards and practices in Software Engineering. It prepares students to acquire skills and disciplines required for designing, writing and modifying software components, modules and applications that comprise software solutions.

5.2.2 Bachelor of Science in Information Systems (BSIS)

The BS Information Systems Program includes the study of application and effect of information technology to organizations. Graduates of the program should be able to implement an information system, which considers complex technological and organizational factors affecting it. These include components, tools, techniques, strategies, methodologies, etc.

Graduates are able to help an organization determine how information and technology-enabled business processes can be used as strategic tool to achieve a competitive advantage. As a result, IS professionals require a sound understanding of organizational principles and practices so that they can serve as an effective bridge between the technical and management/users communities within an organization. This enables them to ensure that the organization has the information and the systems it needs to support its operations.

5.2.3 Bachelor of Science in Information Technology (BSIT)

The BS Information Technology program includes the study of the utilization of both hardware and software technologies involving planning, installing, customizing, operating, managing and administering, and maintaining information technology infrastructure that provides computing solutions to address the needs of an organization.

The program prepares graduates to address various user needs involving the selection, development, application, integration and management of computing technologies within an organization.

5.3 Program Goals

The BSCS, BSIS, and BSIT graduates are expected to become globally competent, innovative, and socially and ethically responsible computing professionals engaged in life-long learning endeavours. They are capable of contributing to the country's national development goals.

5.4 Specific Professions/careers/occupations for Graduates

A. Bachelor of Science in Computer Science (BSCS)

Primary Job Roles

- Software Engineer
- Systems Software Developer
- Research and Development computing professional
- Applications Software Developer
- Computer Programmer

Secondary Job Roles

- Systems Analyst
- Data Analyst
- Quality Assurance Specialist
- Software Support Specialist

B. Bachelor of Science in Information Systems (BSIS)

Primary Job Roles

- Organizational Process Analyst
- Data Analyst

- Solutions Specialist
- Systems Analyst
- IS Project Management Personnel

Secondary Job Roles
- Applications Developer
- End User Trainer
- Documentation Specialist
- Quality Assurance Specialist

C. Bachelor of Science in Information Technology (BSIT)

Primary Job Roles
- Web and Applications Developer
- Junior Database Administrator
- Systems Administrator
- Network Engineer
- Junior Information Security Administrator
- Systems Integration Personnel
- IT Audit Assistant
- Technical Support Specialist

Secondary Job Roles

- QA Specialist
- Systems Analyst
- Computer Programmer

5.5 Allied Fields

In general, subject to the specific provision below, the following may be considered as allied fields:

1. Basic Sciences, Math and Engineering
2. Programs that have at least 50% of core and professional courses of a specific ITE program
3. Any program deemed to be an allied program by the TPITE such as the following:

A. **Bachelor of Science in Computer Science (BSCS)**

- Applied Mathematics
- Computer Engineering
- Electrical Engineering
- Electronics Engineering
- Entertainment and Multimedia Computing
- Mathematics
- Physics
- Statistics

B. **Bachelor of Science in Information Systems (BSIS)**

- Applied Mathematics
- Industrial Engineering
- Information Management
- Library and Information Science
- Statistics
- Informatics

C. **Bachelor of Science in Information Technology (BSIT)**

- Computer Engineering
- Electrical Engineering
- Electronics Engineering
- Informatics
- Information Management

Section 6 Program Outcomes

The minimum standards for the BSCS, BSIS, and BSIT programs are expressed in the following minimum set of graduate outcomes. The graduate outcomes common to all programs, and those common to the discipline are further mapped into the expanded graduate outcomes specific to the sub-disciplines of CS, IS, and IT, as outlined in Section 6.3.

6.1 Common to all programs in all types of schools

The graduates have the ability to

a) articulate and discuss the latest developments in the specific field of practice. (Philippine Qualifications Framework (PQF) level 6 descriptor) (Graduate Outcomes: CS10, IS10, IT13)
b) effectively communicate orally and in writing using both English and Filipino (Graduate Outcomes: CS08, IS08, IT10)
c) work effectively and independently in multi-disciplinary and multi-cultural teams. (PQF level 6 descriptor) (Graduate Outcomes: CS07, IS07, IT08)
d) act in recognition of professional, social, and ethical responsibility (Graduate Outcomes:CS09, IS09, IT12)
e) preserve and promote "*Filipino historical and cultural heritage*" (based on RA 7722)

6.2 Common to the discipline

The graduates of BSCS, BSIS, and BSIT must have the ability to

a) analyze complex problems, and identify and define the computing requirements needed to design an appropriate solution (Graduate Outcomes:CS02, IS02-03, IT03)
b) apply computing and other knowledge domains to address real-world problems (Graduate Outcomes: CS01, IS01, IT01)
c) design and develop computing solutions using a system-level perspective (Graduate Outcomes: CS03-05, IS04-05, IT05)
d) utilize modern computing tools (Graduate Outcomes: CS06, IS06, IT07)

6.3 Specific to a sub-discipline and a major

A. Bachelor of Science in Computer Science (BSCS)

Graduate Attribute	Graduate Outcomes Code	Graduate Outcomes
Knowledge for Solving Computing Problems	**CS01**	Apply knowledge of computing fundamentals, knowledge of a computing specialization, and mathematics, science, and domain knowledge appropriate for the computing specialization to the abstraction and conceptualization of computing models from defined problems and requirements.
Problem Analysis	**CS02**	Identify, analyze, formulate, research literature, and solve complex computing problems and requirements reaching substantiated conclusions using fundamental principles of mathematics, computing sciences, and relevant domain disciplines
Design/Development of Solutions	**CS03**	An ability to apply mathematical foundations, algorithmic principles and computer science theory in the modeling and design of computer-based systems in a way that demonstrates comprehension of the tradeoffs involved in design choices
	CS04	Knowledge and understanding of information security issues in relation to the design, development and use of information systems
	CS05	Design and evaluate solutions for complex computing problems, and design and evaluate systems, components, or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
Modern Tool Usage	**CS06**	Create, select, adapt and apply appropriate techniques, resources and modern computing tools to complex computing activities, with an understanding of the limitations to accomplish a common goal
Individual & Team Work	**CS07**	Function effectively as an individual and as a member or leader in diverse teams and in multidisciplinary settings
Communication	**CS08**	Communicate effectively with the computing community and with society at large about complex computing activities by being able to comprehend and write effective reports, design documentation, make effective presentations, and give and understand clear instructions
Computing Professionalism and Ethics	**CS09**	An ability to recognize the legal, social, ethical and professional issues involved in the utilization of computer technology and be guided by the adoption of appropriate professional, ethical and legal practices
Life-Long Learning	**CS10**	Recognize the need, and have the ability, to engage in independent learning for continual development as a computing professional

B. Bachelor of Science in Information Systems (BSIS)

Graduate Attribute	Graduate Outcomes Code	Graduate Outcomes
Knowledge for Solving Computing Problems	IS01	Apply knowledge of business processes, computing, mathematics and social sciences appropriate to Information Systems

Problem Analysis	IS02	Analyze a problem, identify and define the computing requirements with respect to organizational factors appropriate to its solution and plan strategies for their solution
	IS03	Evaluate information systems in terms of general quality attributes and possible trade-offs presented within the given requirement
Design/Development of Solutions	IS04	Design, implement, and evaluate information systems, processes, components, or programs and to source cost-benefit efficient alternatives to meet desired needs, goals and constraints
	IS05	Use knowledge and understanding of enterprises in modelling and design of information systems
Modern Tool Usage	IS06	Deploy and use effectively skills, tools and techniques necessary for information systems practice
Individual and Team Work	IS07	Function effectively on teams(recognizing the different roles within a team and different ways of organizing teams) to accomplish a common goal
Communication	IS08	Communicate effectively with a range of audiences. Communication skills includes techincal writing, presentation and neogitation, and numeracy.
Computing Professionalism and Ethics in the Society	IS09	Recognize the legal, social, ethical and professional issues involved in the exploitation of computer technology and be guided by the adoption of appropriate professional, ethical and legal practices both in the local and global community
Life-Long Learning	IS10	Recognize the need for and engage in an independent and life-long learning, planning self-learning and improving performance as the foundation for on-going professional development

C. Bachelor of Science in Information Technology (BSIT)

Graduate Attribute	Graduate Outcomes Code	Graduate Outcomes
Knowledge for Solving Computing Problems	IT01	Apply knowledge of computing, science, and mathematics appropriate to the discipline
	IT02	Understand best practices and standards and their applications
Problem Analysis	IT03	Analyze complex problems, and identify and define the computing requirements appropriate to its solution
	IT04	Identify and analyze user needs and take them into account in the selection, creation, evaluation and administration of computer-based systems
Design/Development of Solutions	IT05	Design, implement, and evaluate computer-based systems, processes, components, or programs to meet desired needs and requirements under various constraints
	IT06	Integrate IT-based solutions into the user environment effectively
Modern Tool Usage	IT07	Apply knowledge through the use of current techniques, skills, tools and practices necessary for the IT profession
Individual and Team Work	IT08	Function effectively as a member or leader of a development team recognizing the different roles within a team to accomplish a common goal
	IT09	Assist in the creation of an effective IT project plan
Communication	IT10	Communicate effectively with the computing community and with society at large about complex computing activities through logical writing, presentations, and clear instructions

Computing Professionalism and Social Responsibility	IT11	Analyze the local and global impact of computing information technology on individuals, organizations, and society
	IT12	Understand professional, ethical, legal, security and social issues and responsibilities in the utilization of information technology.
Life-Long Learning	IT13	Recognize the need for and engage in planning self-learning and improving performance as a foundation for continuing professional development

6.4 Common to a horizontal type as defined in CMO 46 s 2012

- Graduates of professional institutions demonstrate a service orientation in one's profession
- Graduates of colleges participate in various types of employment, development activities, and public discourses particularly in response to the needs of the communities one serves
- Graduates of universities participate in the generation of new knowledge or in research and development projects

Graduates of State Universities and Colleges must, in addition, have the competencies to support "national, regional and local development plans." (RA 7722)

A PHEI, at its option, may adopt mission-related program outcomes that are not included in the minimum set.

Section 7 Minimum Performance Indicators

Graduate attributes can be assessed through set of performance indicators provided in the following table.

Graduate Attribute	Performance Indicators
Knowledge for Solving Computing Problems	Completed and successfully defended Capstone Project /Thesis in line with the discipline.
Problem Analysis	Documented software/hardware requirements specifications following computing industry standards.
Design/Development of Solutions	Designed and developed a computing solution using object-oriented approach.
Modern Tool Usage	Used an integrated development environment.
Individual & Team Work	Worked in a group to develop a machine project.
Communication	Presented a proposed solution in class or in a public forum.
Computing Professionalism and Ethics	Immersed/exposed in an actual working environment in industry.
Life-Long Learning	Created a report on a conducted independent learning activity.

An institution may enhance the minimum performance indicators using an industry or globally accepted reference competency inventory.

ARTICLE V
CURRICULUM

Section 8 Curriculum Description

Section 8.1 General Description

The curricula for BSCS, BSIS, and BSIT shall include the required GE courses, six (6) core courses common to all programs, professional courses required for each program, and electives as well as domain specific courses when needed. The students are also required to undertake practicum work and complete a thesis or capstone project.

	BSCS	BSIS	BSIT
General Education	54.0	54.0	54.0
Common Courses	18.0	18.0	18.0
Professional Courses	48.0	48.0	48.0
Professional Electives	9.0	12.0	12.0
Additional Math Requirement	3.0	0.0	0.0
PE	8.0	8.0	8.0
NSTP	6.0	6.0	6.0
Minimum Total Units	**146.0**	**146.0**	**146.0**

The minimum total number of units is 146. For the Centers of Excellence (COEs), the Professional Courses and Electives, and Additional Math Requirement may have a minimum of 48 units (instead of 60) as long as the learning outcomes of the knowledge areas are met, resulting to a minimum total number of 134 units.

The General Education courses for the BSCS, BSIS, and BSIT programs shall be as follows:

GENERAL EDUCATION	Units	Total Units
Language and Humanities		**24**
English	9	
Filipino	6	
Humanities (Literature, Arts, Philosophy, etc.)	9	
Mathematics, Natural Sciences and Technology		**15**
Mathematics (Algebra, Statistics)	6	
Natural Sciences	6	
Electives (Trigonometry, Physics, Science and Society, etc.)	3	
Social Sciences & Communications		**15**
Life & Works of Rizal	3	
Philippine History & Culture	3	
Psychology, Sociology, Anthropology, Economics (w/ Taxation & Agrarian Reform Integrated), Asian/Western Civilization, Mass Comm., Society and Culture (w/ Family Planning), Politics & Governance (w/ Philippine Constitution)	9	

The common courses for the BSCS, BSIS, and BSIT programs shall be as follows:

- Introduction to Computing
- Computer Programming 1 (Fundamentals of Programming)
- Computer Programming 2 (Intermediate Programming)
- Data Structures and Algorithms
- Information Management
- Applications Development and Emerging Technologies

HEIs shall comply with the minimum requirements prescribed in this PSG. In addition, they may enrich the prescribed curricula with additional courses based on their institutional and program goals and objectives.

COURSE SPECIFICATIONS: CORE COMPUTING COURSES

CC100 -- INTRODUCTION TO COMPUTING

This course provides an overview of the Computing Industry and Computing profession, including Research and Applications in different fields; an Appreciation of Computing in different fields such as Biology, Sociology, Environment and Gaming; an Understanding of ACM Requirements; an Appreciation of the history of computing; and Knowledge of the Key Components of Computer Systems (Organization and Architecture), Malware, Computer Security, Internet and Internet protocols, HTML4/5 and CSS.

Course Credits : 3 units
Course Pre-Requisite : None

CC101 -- PROGRAMMING 1

The course covers the use of general purpose programming language to solve problems. The emphasis is to train students to design, implement, test, and debug programs intended to solve computing problems using fundamental programming constructs.

Course Credits : 3 units
Pre-Requisite : None

CC102 -- PROGRAMMING 2

This course is a continuation of CC101 – Programming 1. The emphasis is to train students to design, implement, test, and debug programs intended to solve computing problems using basic data structures and standard libraries.

Course Credits : 3 units
Pre-Requisite : CC101 -- Programming 1

CC103 -- DATA STRUCTURES AND ALGORITHMS

The course covers the standard data representation and algorithms to solve computing problems efficiently (with respect to space requirements and time complexity of algorithm). This covers the following: Stacks, Queues, Trees,

Graphs, Maps, and Sets. Thorough discussion of sorting and searching algorithms and hashing is covered.

Course Credits : 3 units
Pre-Requisite : CC102 – Programming 2

CC104 – INFORMATION MANAGEMENT

This course covers information management, database design, data modeling, SQL, and implementation using relational database system.

Course Credits : 3 units
Course Pre-Requisite : CC103 – Data Structures and Algorithms

CC105 – APPLICATIONS DEVELOPMENT AND EMERGING TECHNOLOGIES

Development of applications using web, mobile, and emerging technologies with emphasis on requirements management, interface design, usability, testing, deployment, including ethical and legal considerations.

Course Credits : 3 units
Pre-Requisite : CC102 – Programming 2

Section 8.2 Specific Description of Program Curricula

A. Bachelor of Science in Computer Science (BSCS)

The Computer Science curriculum includes foundation and professional courses that cover theory, algorithms, software design and development, and new developments in computing.

The curriculum should include courses in the following Knowledge Areas as recommended in ACM Computer Science Curricula 2013[1]:

1. Algorithms and Complexities
    a. Design and Analysis of Algorithms
    b. Automata Theory and Formal Languages
    c. Computational Science
2. Architecture and Organization
3. Discrete Structures
    a. Logic, Sets, Relations, Functions, and Proof Techniques
    b. Graphs, Trees, Matrices, Combinatorics and Recurrences
4. Human Computer Interaction
    a. Fundamentals of HCI
    b. Graphics and Visual Computing
5. Information Assurance and Security
6. Networks and Communications
7. Operating Systems

[1] acm.org

a. Fundamentals of Operating Systems
b. Parallel and Distributing Computing

8. Programming Languages (Design and Implementation)
9. Software Development Fundamentals
    a. Fundamentals of Programming
    b. Intermediate Programming
    c. Data Structures and Algorithms
    d. Object Oriented Programming
10. Software Engineering
    a. Analysis and Design
    b. Implementation and Management
    c. Intelligent Systems
11. Social Issues and Professional Practice

B. Bachelor of Science in Information Systems (BSIS)

The Information Systems curriculum encompasses introductory and professional courses to cover the various information systems functional areas as follows:

1. Fundamentals of IS
2. Professional Issues in Information Systems
3. IT Infrastructure and Network Technologies
4. Systems Analysis, Design and Development
5. Enterprise Architectures
6. IS Project Management
7. IS Strategy, Management and Acquisition

In addition, the curriculum shall include business enterprise domain courses such as the following:

1. Organization and Management Concepts
2. Financial Management
3. Business Process Design and Management
4. Evaluation of Business Performance
5. Quantitative Methods

C. Bachelor of Science in Information Technology (BSIT)

The Information Technology curriculum includes basic and advanced courses on planning, development, integration, and management of information technology infrastructure that provide computing solutions to address the needs of organizations.

The curriculum should include courses in the following Knowledge Areas as recommended in ACM Information Technology Curricula 2008[2]:

1. Information Technology Fundamentals
2. Human Computer Interaction
3. Information Assurance and Security

[2] acm.org

- Fundamentals of IAS
- Advanced Topics of IAS

4. Information Management
    - Fundamentals of IM
    - Fundamentals of Database Systems
    - Advanced Database Systems
5. Integrative Programming and Technologies
    - Fundamentals of Programming
    - Intermediate Programming
    - Data Structures and Algorithms
    - Object Oriented Programming
    - Event Driven Programming
6. Networking
    - Fundamentals of Networking
    - Advanced Networking
7. Platform Technologies
    - Intangible Technologies
    - Tangible Technologies
8. Systems Administration and Maintenance
9. Systems Integration and Architecture
    - Fundamentals of SIA
    - Advanced SIA
10. Social and Professional Issues
11. Web Systems and Technologies

Section 8.3 Internship/On-the-job-training/Practicum.

Internship/OJT/Practicum is an immersion program wherein the students will have the chance and opportunity to be with the IT industry. This program is important because the students will have the chance to apply the skills, knowledge and attitude learned in the school and at the same time the opportunity to experience the corporate environment. Learning expectations in the IT related field should be established between the HEI and the industry in the form of a Memorandum of Agreement (MOA) or Memorandum of Understanding (MOU).

Internship is a requirement for the BSCS, BSIS and BSIT programs. Students are eligible to enroll the internship program after completing 70% of the total number of units in the curriculum. The minimum number of internship hours (preferably in a full time capacity) for the BSIS and BSIT programs is 486 hours and 162 hours for the BSCS program.

Section 8.4 Thesis/Capstone Project

Thesis is required for BSCS while Capstone Project is required for BSIS and BSIT. Both function as terminal project requirements that would not only demonstrate a student's comprehensive knowledge of the area of study and research

methods used but also allow them to apply the concepts and methods to a specific problem in their area of specialization.

BS Computer Science students are required to complete a thesis that is focused on the theories and concepts of computing in the form of a scientific work.

BS Information Systems students must complete a project such as business application development, or an Information Systems plan.

BS Information Technology students must complete a capstone project such as a software/system development with emphasis on the IT infrastructure, or an IT Management project.

It is expressly understood that Computing Thesis and Capstone Projects need not require surveys, statistics, and descriptive methods, unless appropriate.

a. A **Thesis** is a technical report on a systematic investigation of a problem that can be solved using Computing. It may include a solution, an approximate or partial solution, a scientific investigation, or the development of results leading to the solution of the problem.

   A Computer Science thesis must be anchored on Computer Science principles.

b. A **Capstone Project** is an undertaking appropriate to a professional field. It should significantly address an existing problem or need.

   An Information Systems Capstone Project focuses on business processes and the implications of introducing a Computing solution to a problem.

   An Information Technology Capstone Project focuses on the infrastructure, application, or processes involved in implementing a Computing solution to a problem.

Scope of the Theses / Capstone Projects

The Thesis or Capstone Project should integrate the different courses, knowledge, and competencies learned in the curriculum. Students are encouraged to produce innovative results, generate new knowledge or theories, or explore new frontiers of knowledge or application areas.

The HEI should have specific guidelines on Thesis and Capstone Projects. Attached as Annex A is a sample guideline.

Section 9 Sample Curriculum

9.1. Components
General Education. Core Courses, Electives, etc.

A. Bachelor of Science in Computer Science (BSCS)

The following is a list of professional and elective courses in the sample curriculum for BSCS:

Course Code	Knowledge Area Code	Course Title	Units
Required Courses			
CC101	CC	Introduction to Computing	3.0
CC102	SDF	Fundamentals of Programming	3.0
CC103	SDF	Intermediate Programming	3.0
CC104	SDF	Data Structures and Algorithms	3.0
CC105	IM	Information Management	3.0
CC106	IM	Applications Development and Emerging Technologies	3.0
DS101	DS	Discrete Structures 1	3.0
DS102	DS	Discrete Structures 2	3.0
SDF 104	SDF	Object-oriented Programming	3.0
AL101	AL	Algorithms and Complexity	3.0
AL102	AL	Automata Theory and Formal Languages	3.0
AR101	AR	Architecture and Organization	3.0
IAS101	IAS	Information Assurance and Security	2.0
HCI101	HCI	Human Computer Interaction	1.0
NC101	NC	Networks and Communications	3.0
OS101	OS	Operating Systems	3.0
PL101	PL	Programming Languages	3.0
PRC101	PRC	Practicum	3.0
SE101	SE	Software Engineering 1	3.0
SE102	SE	Software Engineering 2	3.0
SP101	SP	Social Issues and Professional Practice	3.0
THS102	THS	CS Thesis Writing 1	3.0
THS103	THS	CS Thesis Writing 2	3.0
Recommended Electives			
CN101	CN	Computational Science	3.0
GV101	GV	Graphics and Visual Computing	3.0
PD101	PD	Parallel and Distributed Computing	3.0
IS101	IS	Intelligent Systems	3.0
SF101	SF	System Fundamentals	3.0

Bachelor of Science in Information Systems (BSIS)

The following is a list of professional and elective courses in the sample curriculum for BSIS:

Course Code	Knowledge Area Code	Course Title	Units
CC101	ITF	Introduction to Computing	3
CC102	PF	Computer Programming 1	3
CC103	PF	Computer Programming 2	3
CC104	PIF	Data Structures and Algorithms	3
CC105	DIM	Information Management	3
CC106	UE	Application Development and Emerging Technologies	3
IS101	FIS	Fundamentals of Information Systems	3
IS102	PIS	Professional Issues in Information Systems	3
IS103	NIT	IT Infrastructure and Network Technologies	3
IS104	SAD	Systems Analysis and Design	3
IS105	EA	Enterprise Architecture	3
IS106	IPM	IS Project Management 1	3
IS107	ISMA	IS Strategy, Management and Acquisition	3
DM101	DBC	Organization and Management Concepts	3
DM102	DBC	Financial Management	3
DM103	DBC	Business Process Management	3
DM104	DBC	Evaluation of Business Performance	3
QUAMET	MATH	Quantitative Methods	3
CAP101	CAP	Capstone Project 1	3
CAP102	CAP	Capstone Project 2	3
PRAC101	PRC	Practicum for Information Systems	6
		Recommended Electives	
ADV01	ITD	Enterprise Systems	3
ADV02	ITD	Human Computer Interaction	3
ADV03	BD	IT Audit and Controls	3
ADV04	BD	IS Innovations and New Technologies	3
ADV05	ITD	IT Security and Management	3
ADV06	ITD	IT Service Management	3
ADV07	ITD	IS Project Management 2	3
ADV08	ITD	Data Mining	3
ADV09	BD	Business Intelligence	3
ADV10	BD	Enterprise Resource Planning	3
ADV11	BD	Supply Chain Management	3
ADV12	BD	Customer Relationship Management	3

Bachelor of Science in Information Technology (BSIT)

The following is a list of professional and elective courses in the sample curriculum for BSIT:

Course Code	Knowledge Area Code	Course Title	Units
CC101	CP	Introduction to Computing	3
CC102	PF	Computer Programming 1	3
CC103	PF	Computer Programming 2	3
CC104	PF	Data Structures and Algorithms	3
CC105	IM	Information Management	3
CC106	WS	Application Development and Emerging Technologies	3

HCI101	HCI	Introduction to Human Computer Interaction	3
IAS101	IAS	Information Assurance and Security 1	3
IAS102	IAS	Information Assurance and Security 2	3
IM101	IM	Fundamentals of Database Systems	3
IPT101	IPT	Integrative Programming and Technologies 1	3
MS101	MS	Discrete Mathematics	3
MS102	MS	Quantitative Methods (incl. Modeling & Simulation)	3
NET101	NET	Networking 1	3
NET102	NET	Networking 2	3
PRAC101	PRC	Practicum	6
SA101	SA	Systems Administration and Maintenance	3
SIA101	SIA	Systems Integration and Architecture 1	3
SP101	SP	Social and Professional Issues	3
CAP101	THS	Capstone Project and Research 1	3
CAP102	THS	Capstone Project and Research 2	3
Recommended Electives			
IPT102	IPT	Integrative Programming Technologies 2	3
PT101	PT	Platform Technologies	3
WS101	WS	Web Systems and Technologies	3
PF101	PF	Object-Oriented Programming	3
SIA102	SIA	Systems Integration and Architecture 2	3
HCI102	HCI	Human Computer Interaction 2	

9.2. Sample Program of Study

A. Bachelor of Science in Computer Science (BSCS)

Year	Freshmen Year		Sophomore Year		Junior Year			Fourth Year		TOTAL
Sem	1st	2nd	1st	2nd	1st	2nd	Summer	1st	2nd	
TOTAL	**18.5**	**18.5**	**18.5**	**18.5**	**20.0**	**18.0**	**3.0**	**19.0**	**12.0**	**146.0**
GE	**9.0**	**9.0**	**6.0**	**6.0**	**6.0**	**6.0**		**6.0**	**6.0**	**54.0**
Common	**6.0**	**3.0**	**3.0**	**3.0**	**3.0**					**18.0**
Prof		**3.0**	**6.0**	**3.0**	**8.0**	**9.0**	**3.0**	**10.0**	**6.0**	**48.0**
Electives				**3.0**	**3.0**	**3.0**		**3.0**		**12.0**
PE	**2.0**	**2.0**	**2.0**	**2.0**						**8.0**
NSTP	**1.5**	**1.5**	**1.5**	**1.5**						**6.0**
CS Units	6	6	9	9	14	12	3	13	6	78
	CC101* Introduction to Computing									
AL				AL101* Algorithms and Complexity	AL102* Automata Theory and Formal Languages					
AR					AR101* Architecture and Organization					
DS		DS101* Discrete Structures 1	DS102* Discrete Structures 2							
HCI								HCI101* Human Computer Interaction		
IAS					IAS101* Information					

					Assurance and Security					
IM				CC105 (IM101)** Information Management						
NC									NC101** Networks and Communications	
OS								OS101** Operating Systems		
PL						PL101** Programming Languages				
SDF	CC102 (SDF101)** Fundamentals of programming	CC(103) SDF102** Intermediate Programming	SDF104** Object-oriented Programming CC104 (SDF103)** Data structures and algorithms							
SE						SE101** Software Engineering 1		SE102** Software Engineering 2		
SF										
SP						SP101* Social Issues and Professional Practice 1				
THS								THS101** CS Thesis 1	THS102*** CS Thesis 2	
PRC							PRAC101** Practicum			
Elective				Math Elective*	CS Elec1**	CS Elec 2**		CS Elec 3**		
CC					CC 106** Application Development and Emerging Technologies					

* Pure Lecture

** 2 hours lecture, 3 hours lab per week

*** Supervised Independent Study

B. Bachelor of Science in Information Systems (BSIS)

Year	Freshmen Year		Sophomore Year		Junior Year		Fourth Year		Total
Sem	1st	2nd	1st	2nd	1st	2nd	1st	2nd	
TOTAL	**21.5**	**21.5**	**21.5**	**21.5**	**21**	**21**	**12**	**6**	**146**
GE	**12**	**12**	**6**	**9**	**6**	**9**			**54**
Electives				**3**	**3**	**3**	**3**		**12**
PE	**2**	**2**	**2**	**2**					**8**
NSTP	**1.5**	**1.5**	**1.5**	**1.5**					**6**
IS Units	6	6	12	9	15	12	12	6	78
ITF	CC101** Introduction to Computing								
PIF			CC104** Data Structures						

			and Algorithms						
DIM					CC105** Information Management				
PIS		IS101* Fundamentals of Information Systems	IS102* Professional Issues in Information Systems						
NIT			IS103** IT Infrastructure and Network Technologies						
SAD				IS104** Systems Analysis and Design					
EA					IS105** Enterprise Architecture				
PF	CC102** Computer Programming 1	CC103** Computer Programming 2							
IPM						IS106* IS Project Management 1			
ISMA							IS107* IS Strategy Management and Acquisition		
UE							CC106** Application Development and Emerging Technologies		
DBC			DM101* Organization and Management Concepts	DM102* Financial Management	DM103* Business Process Management	DM104* Evaluation of Business Performance			
MATH					QUAMET* Quantitative Methods				
CAP						CAP101*** Capstone Project 1	CAP102*** Capstone Project 2		
PRC								PRAC101*** Practicum for Information Systems	
ADV (Elective)				PROFEL 1	PROFEL 2	PROFEL 3	PROFEL 4		

* - Pure Lecture

** - 2 hours lecture, 3 hours lab per week

*** - Supervised Independent Study

A. Bachelor of Science in Information Technology (BSIT)

Year	Freshmen Year		Sophomore Year		Junior Year			Fourth Year		Total
Sem	1st	2nd	1st	2nd	1st	2nd	Summer	1st	2nd	
TOTAL	21.5	21.5	21.5	21.5	21	18	6	6	9	146
GE	12	9	9	6	9	9				54
Electives			3	3	3				3	12
PE	2	2	2	2						8
NSTP	1.5	1.5	1.5	1.5						6
IT Units	6	9	9	7	12	[illegible]				[illegible]
ITF	CC101** - Introduction to Computing									
HCI		HCI 101** Introduction to Human Computer Interaction								

IAS						IAS 101** Information Assurance and Security 1	IAS 102** Information Assurance and Security 2			
IM				CC105** Information Management 1	IM 101** Advanced Database Systems					
MS		MS 101* Discrete Mathematics		MS102* Quantitative Methods						
NET				NET 101** Networking 1	NET102** Networking 2					
PF	CC102** Computer Programming 1		CC104** Data Structures and Algorithms							
		CC 103** Computer Programming 2	PF 101** Object Oriented Programming							
SA								SA 101** Systems Administration and Maintenance		
SIA					SIA 101** Systems Integration and Architecture 1					
SP						SP 101* Social and Professional Issues				
WS						CC106** Application Development and Emerging Technologies				
THS							CAP 101*** Capstone Project 1	CAP 102*** Capstone Project 2		
PR									PRAC 101*** Practicum	
ADV (Elective)			PT 101** Platform Technologies	IPT 101** Integrative Programming and Technologies	PF 101** Event Driven Programming				SIA 102** Systems Integration and Architecture 2	

* - Pure Lecture

** - 2 hours lecture, 3 hours lab per week

*** - Supervised Independent Study

Section 10 Sample Curriculum Map

Curriculum Map for the Bachelor of Science in Computer Science

Course Code	Knowledge Area	Course Title	Pre-Requisite	Units	Sample Learning Outcomes		CS01	CS02	CS03	CS04	CS05	CS06	CS07	CS08	CS09	CS10
CC101	CC	Introduction to Computing	None	3	LO1	Explain fundamental principles, concepts and evolution of computing systems as they relate to different fields								I	I	I
					LO2	Expound on the recent developments in the different computing knowledge areas										
					LO3	Analyze solutions employed by organizations to address different computing issues										

CC102	SDF	Fundamentals of Programming	None	3	LO1	Design, implement, test, and debug a program, based on a given specification, that uses each of the following fundamental programming components: (1) primitive data types, (2) basic computation, (3) simple I/O, (4) conditional and iterative structures, (5) definition of functions and parameter passing, and(6) recursion	I	I	I			I				
					LO2	Assess and recommend revisions to another programmer's code (1) regarding documentation and program style standards that contribute to readablity and maintainability of software, (2) regarding appropriateness of chosen conditional and iterative constructs given a programming task, and (3)regarding thoroughness in applying procedural abstraction										
CC103	SDF	Intermediate Programming	SDF101	3	LO1	Design, implement, test, and debug a program, based on a given specification, that uses (1) data structures arrays, strings, structures, linked list,and files, (2) conditional, iterative and recursive constructs, and (3) standard libraries in the assigned programming language	I	I	I			I				
					LO2	Assess and recommend revisions to another programmer's code (1) regarding appropriateness of chosen data structure, (2) regarding appropriateness of chosen conditional and iterative constructs given a programming task, and (3)regarding thoroughness in applying procedural abstraction										
					LO3	Argue the costs and benefits of dynamic and static data structure implementations										
CC104	SDF	Data Structures and Algorithms	SDF102	3	LO1	Design, implement, test, and debug a program, based on a given specification, that uses and implements abstract data types (stacks queues, priority queues, sets, maps)	E	E	E		I					
					LO2	Argue strengths and weaknesses among multiple implementations for a problem (i.e., on the aspects of iterative vs. recursive solutions and on the aspects of abstraction,encapsulation, and information hiding)										
CC105	IM	Information Management	SDF102	3	LO1	Analyze an existing database system with respect to quality issues: Reliability, scalability, efficiency, effectiveness and security	E	E	E	E	E	E	E	E		I
					LO2	Design a database based on user requirements using a widely used modeling notation, and be able to use declarative query language to elicit information										
CC106	IM/ CC	Applications Development and Emerging Technologies	IM101/ CC105	3	LO1	Develop specifications for a software development effort that precisely articulates the functional requirements expected execution paths, and the explicit use of cutting edge or emerging technologies, which includes hardware devices and software library APIs	E	E	E		E					
					LO2	Select and use a defined coding, documentation writing, and licensing standards in a sufficiently complex software project where coding idioms and mechanisms for implementing designs to achieve desired properties such as reliability, efficiency, and robustness are practiced with respect to legal and ethical considerations.										
					LO3	Undertake, as part of a team activity, an inspection of the source code and unit testing of the functional units of a sufficiently complex software project.										

SDF 104	SDF	Object-oriented Programming	SDF102	3	LO1	Compare and contrast procedural/functional approach to object-oriented programming approach.	E	E	E			E	I			
					LO2	Design, implement, test and debug programs using OOP concepts like abstraction, encapsulation, inheritance and polymorphism										
DS101	DS	Discrete Structures 1	ALTRIG	3	LO1	Perform the operations associated with Sets, Functions and Relations, and relate these operations to computer programming	I	I	I		I					
					LO2	Construct sound arguments in propositional and predicate logic by applying appropriate rules of inference given sample intelligent software										
					LO3	Construct valid mathematical proofs using mathematical induction, direct proof and proof by contradiction to simplify programs and prove program correctness										
DS102	DS	Discrete Structures 2	DS101	3	LO1	Solve real-world computing problems that require mapping to permutations, combinations of a set, and modular arithmetic	I	I	I		I					
					LO2	Compute the event probabilities using counting and Bayes Theorem of a sample computing problem										
					LO3	Solve equations involving recurrence and relate them to recursive algorithms										
PL101	PL	Programming Languages	SDF103	3	LO1	Reason about memory leaks, dangling-pointer dereferences, and the benefits and limitations of garbage collection through an understanding of programming language implementation and how memory is organized.	E	E	E					E		E
					LO2	Evaluate the appropriateness of the use of a programming language for implementing a particular application based on language features										
					LO3	Implement a simple interpreter or a portion of the language translation process such as a lexical analyzer, parser, code generator or optimizer										
AL101	AL	Algorithms and Complexity	DS101 SDF103	3	LO1	Use big O notation formally to give asymptotic upper bounds on time and space complexity of algorithms	E	E	E		E					
					LO2	Choose and apply the most appropriate algorithm design technique (divide and conquer, backtracking, greedy, dynamic programming) for solving problems										
					LO3	Describe the behavior and running time of various searching, sorting, and graph algorithms.										
AL102	AL	Automata Theory and Formal Languages	AL101	3	LO1	Design finite-state machines, regular expressions, context-free grammar, push-down automata and turing machines for modeling a given language; and define the classes P and NP and explain their significance to computing applications	E	E	E		E					
					LO2	Apply the concept of state machines in the design and implementation of software										

NC101	NC	Networks and Communicatio ns	SDF102	3	LO1	Implement a simple client-server socket-based application that meets the needs of an organization against security threats;	E	E	E	E	E			E	E
					LO2	Design and implement a simple reliable network protocol through the diagnosis and fixing of common network problems;									
					LO3	Compare and contrast the fixed and dynamic allocation techniques									
OS101	OS	Operating Systems	SDF103	3	LO1	Analyze the tradeoffs inherent in OS design	E	E	E	E		E		E	E
					LO2	Compare and contrast the algorithms used for processor scheduling and the different ways of allocating memory to tasks									
					LO3	Design and create concurrent programs considering synchronization issues									
AR101	AR	Architecture and Organization	DS101 SDF103	3	LO1	Design the basic building blocks of a computer: arithmetic-logic unit (gate-level), registers (gate-level), central processing unit (register transfer-level), memory (register transfer-level)	E	E	E						
					LO2	Write simple programs in assembly language.									
SP101	SP	Social Issues and Professional Practice 1	SE102	3	LO1	Argue the pros and cons of the design and implemention of computing solutions in education, industry and government, to name a few							E	E	E	E
					LO2	Evaluate professional, ethical and social issues of computing decisions									
SE101	SE	Software Engineering 1	IM101 SDF104	3	LO1	Discuss the difference between the waterfall-based models and agile-based models, and identify the strengths and weaknesses of these models	E	E	E	E	E	E	E	E	E
					LO1	Discuss the difference between the waterfall-based models and agile-based models and identify the strengths and weaknesses of these models									
					LO2	Extract user requirements, translate these to formal models, and present these using UML-based visualizations									
					LO3	Design an over-all architecture of the system, and justify its appropriateness									
					LO4	Translate program designs and specifications into actual program codes									
SE102	SE	Software Engineering 2	SE101	3	LO1	Improve an existing software by adopting an appropriate design pattern	D	D	D	D	D	D	D	D	D
					LO2	Translate program designs and specifications into actual program codes									
					LO3	Design test case documents applying good testing practices, run the existing program against these test cases, and report program defects properly									
					LO4	Update a software that requires defect fixing or has undergone some changes in specifications									

IAS101	IAS	Information Assurance and Security	IM101	2	LO1	Describe the set of controls and processes both technical and policy intended to protect and defend information and information systems by ensuring their availability, integrity, authentication, and confidentiality and providing for non-repudiation.		E		E	E			E	E	E
					LO2	Articulate the strengths and weaknesses associated with different approaches to security to the validity of current and past processes and data												
HCI101	HCI	Human Computer Interaction	SDF102	1	LO1	Develop appropriate user interfaces for domain specific applications		E		E	E	E	E	E	E			
					LO2	Evaluate the effectiveness of a design of an application or product in solving domain-specific problems												
THS101	THS	CS Thesis 1	4th Year Standing	3	LO1	Formulate the research objectives, scope and limitations, and evaluation metric for a chosen topic	D	D	D	D	D	D	D	D	D	D		
					LO2	Collect and compare related literature related to the topic												
					LO3	Propose an ethical and feasible software solution to the identified research problem that employs new designs, tools, and methodologies, as well as unique and useful enhancements, with creating a prototype software system in mind or with demonstrating that a certain theory / algorithm / design might work through exploratory and experimental research												
THS102	THS	CS Thesis 2	THS101	3	LO1	Collect pertinent data to support research objectives of the thesis	D	D	D	D	D	D	D	D	D	D		
					LO2	Design the architecture and components of the proposed software solution												
					LO3	Justify the proposed solution's feasibility and effectiveness to solve the computing problem												
PRC101	PRC	Practicum	3rd Standing	3	LO1	Analyze, design, implement, test, maintain, and/or document a software system as applied to a real-world problem, as part of a team in an actual company environment, thereby also developing personal and interpersonal working skills in the process	D	D	D	D	D	D	D	D	D	D		

Curriculum Map for the Bachelor of Science in Information Systems

Course Code	Course Title	Pre-Requisite Course	Units	Sample Learning Outcomes		IS01	IS02	IS03	IS04	IS05	IS06	IS07	IS08	IS09	IT10
CC101	Introduction to Computing	None	3	LO1	Explain fundamental principles, concepts and evolution of computing systems as they relate to different fields	I									
				LO2	Expound on the recent developments in the different computing knowledge areas						I			I	I
				LO3	Analyze solutions employed by organizations to address different computing issues									I	

CC102	Computer Programming 1	None	3	LO1	Design, implement, test, and debug a program, based on a given specification, that uses each of the following fundamental programming components: (1) primitive data types, (2) basic computation, (3) simple I/O, (4) conditional and iterative structures, (5) definition of functions and parameter passing, and(6) recursion	I	I	I	I	I					
				LO2	Analyze and simulate results of algorithms that may be implemented as a solution to a given problem										
CC103	Computer Programming 2	CC102		LO1	Design, implement, test, and debug a program, based on a given specification, that uses : (1) data structures arrays, stacks, queues, trees, strings, structures, linked list,and files, (2) conditional, iterative, and recursive constructs, and (3) standard libraries in the assigned programming language	I	I	I	I	I					
CC104	Data Structures and Algorithms Analysis	CC103	3	LO1	Design, implement, test and debug a program based on a given specifications that uses and implement abstract data types (stacks, queues, priority queues, sets, maps)	E	E		E						
				LO2	Argue strengths and weaknesses among multiple implementations for a problem (e g. on the aspects of iterative or recursive solutions and on the aspects of abstraction, encapsulation and information hiding)	E	E		E						
CC105	Information Management	CC104	3	LO1	Integrate business intelligence functions in the development of database systems in enterprises	E	E	E	I	I	E				
CC106	Application Development and Emerging Technologies	4TH Year Standing	3	LO1	Develop specifications for a software development effort that precisely articulates the functional requirements, expected execution paths, and the explicit use of cutting edge or emerging technologies, which includes hardware devices and software library APIs.	E	E	E	D	D	D				
				LO2	Select and use a defined coding, documentation writing, and licensing standards in a sufficiently complex software project where coding idioms and mechanisms for implementing designs to achieve desired properties such as reliability, efficiency, and robustness are practiced with respect to legal and ethical considerations										
				LO3	Undertake, as part of a team activity an inspection of the source code and unit testing of the functional units of a sufficiently complex software project										
IS101	Fundamentals of IS	CC101	3	LO1	Compare and identify the major technologies and applications of information systems in driving development and changes in enterprises	I	I	I	I	I	I				
IS102	Professional Issues in IS	CC101	3	LO1	Examine professional, ethical and moral challenges in computing and use of information systems and recommend courses of action.								E	D	E
				LO2	Apply/exhibit ethical thinking skills in analyzing and finding resolutions to computing issues										
IS103	IT Infrastructure and Network Technologies	CC101	3	LO1	Evaluate how IT infrastructure components are organized into infrastructure solutions in different organizational environments	D	E	E	E	D					

				LO2	Examine, test and evaluation web solutions as applied to business enterprise										
IS104	Systems Analysis and Design	2ND Year Standing	3	LO1	Use systems thinking to analyze business processes and identify problems and opportunites that can be solved and supported by technology solutions	D	D				E				
				LO2	Apply appropriate tools, methods, models/techniques in systems analysis and design	E	E	E	E	D	D	E			
				LO3	Develop and defend a project design proposal to different audiences.			D	D	E	D	E			
IS105	Enterprise Architecture	IS103	3	LO1	Examine and evaluate core concepts of data/information architecture used in existing data/information architecture designs		E	D		D	D				
IS106	IS Project Management 1	IS104		LO1	Examine the use of project management best practices in real-life projects	E	E	E	E	E	E	D			E
				LO2	Apply project management concepts, principles and tools in performing an actual IS project.										
IS107	IS Strategy Management and Acquisition	4TH Year Standing	3	LO1	Examine existing and emerging information technologies, the functions of IS and how it impacts organizational operations				D	D	D				
				LO2	Analyze how strategic decisions are made concerning acquiring IS resources and capabilities including the ability to evaluate the different sourcing options		D	D	E	E					
DM101	Organization and Management Concepts	CC101	3	LO1	Examine and Evaluate organizational structure policies and procedures and the information systems that support them	I	E	E					E	E	D
				LO2	Examine and Evaluate management lifecycle and the information systems that support them	I	E	E					E	E	D
DM102	Financial Management	DM101	3	LO1	Examine and Evaluate financial processes and reports and the information systems that support them	E	E	E	E	E		E			
DM103	Business Process Management	DM102	3	LO1	Use systems thinking in modeling and analyzing business processes		E	E	D	D	E				
				LO2	Rethink processes to simplify business operations		E	E	D	D	E				
DM104	Evaluation of Business Performance	DM103	3	LO1	Evaluate business performance applying the different evaluation tools consistent with quality management and continuous improvement		D	D			D				
				LO2	Develop quality metrics for assessment of customer satisfaction in all phases of life cycle.		D	D			D				
				LO3	Design a business performance management program for SMEs				D	D		E	E	E	
QUAM ET	Quantitative Methods	3rd Year Standing	3	LO1	Use appropriate mathematical tools for decision making.		D	D			D				
				LO2	Implement mathematical methods in IT solutions to problems.		D	D			D				

CAP101	Capstone Project 1	4TH Year Standing	3			D	D	D	D	D	D	D	D	D	D		
CAP102	Capstone Project 2	4TH Year Standing	3			D	D	D	D	D	D	D	D	D	D		
PRAC01	Practicum	4th Year Standing	3	LO1	Analyze, design, implement, test, maintain, and/or document a software system as applied to a real-world problem, as part of a team in an actual company environment, thereby also developing personal and interpersonal working skills in the process	D	D	D	D	D	D	D	D	D	D		

Curriculum Map for the Bachelor of Science in Information Technology

Course Code	Knowledge Area	Course Title	Pre-requisite	Units	Sample Learning Outcomes		IT01	IT02	IT03	IT04	IT05	IT06	IT07	IT08	IT09	IT10	IT11	IT12	IT13
CC101	ITF	Introduction to Computing	None	3	LO1	Explain fundamental principles, concepts and evolution of computing systems as they relate to different fields													
					LO2	Expound on the recent developments in the different computing knowledge areas			I				I			I	I	I	I
					LO3	Analyze solutions employed by organizations to address different computing issues													
CC102	PF	Computer Programming 1	None	3	LO1	Design, implement, test, and debug a program, based on a given specification, that uses each of the following fundamental programming components: (1) primitive data types, (2) basic computation, (3) simple I/O, (4) conditional and iterative structures, (5) definition of functions and parameter passing, and(6) recursion	I						I		I				
					LO2	Analyze and simulate results of algorithms that may be implemented as a solution to a given problem													
CC103	PF	Computer Programming2	CC102	3	LO1	Design, implement, test and debug a program, based on a given specification, that uses (1) data structures arrays, strings, structures, linked list,and files, (2) conditional, iterative, and recursive constructs, and (3) standard libraries in the assigned programming language	E	I			I		E		E	I			I
					LO2	Assess and recommend revisions to another programmer's code (1) regarding appropriateness of chosen data structure, (2) regarding appropriateness of chosen conditional and iterative constructs given a programming task, and (3)regarding thoroughness in applying procedural abstraction													

					LO3	Argue the costs and benefits of dynamic and static data structure implementations												
CC104	PF	Data Structures and Algorithms	CC103	3	LO1	Design, implement, test, and debug a program, based on a given specification, that uses and implements abstract data types (stacks, queues, priority queues, sets, maps)	I						I		I			
					LO2	Argue strengths and weaknesses among multiple implementations for a problem (i.e., on the aspects of iterative vs recursive solutions and on the aspects of abstraction encapsulation, and information hiding)												
CC105	IM	Information Management	CC103	3	LO1	Analyze an existing database system with respect to quality issues Reliability, scalability, efficiency, effectiveness and security	E	E	E	E	E	E	E	E		I		
					LO2	Design a database based on user requirements using a widely used modeling notation, and be able to use declarative query language to elicit information												
CC106	WS	Application Development and Emerging Technologies	IM101	3	LO1	Develop specifications for a software development effort that precisely articulates the functional requirements, expected execution paths, and the explicit use of cutting edge or emerging technologies, which includes hardware devices and software library APIs.	E	E	E	D	D	D						
					LO2	Select and use a defined coding, documentation writing, and licensing standards in a sufficiently complex software project where coding idioms and mechanisms for implementing designs to achieve desired properties such as reliability, efficiency, and robustness are practiced with respect to legal and ethical considerations												
					LO3	Undertake, as part of a team activity, an inspection of the source code and unit testing of the functional units of a sufficiently complex software project.												
MS102	MS	Quantitative Methods	MS101 and Statistics	3	LO1	Use appropriate mathematical tools for decision making		D	D			D						

					LO2	Implement mathematical methods in IT solutions to problems												
PF 101	PF	Object-oriented Programming	CC 103	3	LO1	Compare and contrast procedural/functional approach to object-oriented programming approach.	E	E			E	I	E		E	E		
					LO2	Design, implement, test and debug programs using OOP concepts like abstraction, encapsulation inheritance and polymorphism												
PF102	PF	Event-Driven Programming	CC10 4	3	LO1	Design, code, test and debug simple event-driven programs that respond to user events	E	E			E	I	E		E	E		
HCI101	HCI	Introduction to Human Computer Interaction	CC10 2	3	LO1	Analyze different user populations with regard to their abilities and characteristics for using both software and hardware products.		E	I	I	E	E	E					
					LO2	Evaluate the design of existing user interfaces based on the cognitive models of target user												
HCI102	HCI	Human and Computer Interaction 2		3	LO1	Develop prototypes interfaces for users with specific accessibility issues			E	E	E		E	I		E	E	
					LO2	Perform usability evaluation of an existing software based on general principles used in the heuristic evaluation, usability performance and preference metrics (learning, task time, task completion, and user satisfaction), and common usability guidelines and standards.												
IM101	IM	ADVANCED Database Systems	CC10 5	3	LO1	Examine the different techniques of warehousing and mining data that will support organizational decisions	E	E	E	E			E					
					LO2	Propose possibilities on how to improve a specific algorithm as may be applied to data warehousing and mining.												
PT101	PT	Platform Technologies	CC10 3	3	LO1	Recommend an appropriate operating system based on given system requirements		E	E	E	E	E						
					LO2	Plan and write a simple assembly-language program.												
					LO3	Perform a cost-benefit analysis for a proposed server solution												

NET101	NET	Networking 1	PT101	3	LO1	Describe data communications and network models, topologies, protocols, standards and architectures	E	E	E				E							
					LO2	Describe necessary hardware and components used to establish communication between multiple networks and analyze the effect of various topologies, applications and devices on network performance														
					LO3	Analyze routing algorithms, protocols, process routing tables and configure routers for proper orientation of an efficient network														
NET102	NET	Networking 2	NET101	3	LO1	Design, configure and deploy switches utilizing VLANs, trunking and port aggregation.	E	E	E			E	E			E	E			
					LO2	Implement multiple networks and connect them together, selecting routing and switching equipment for a given network application.														
					LO3	Implement load balancing in routers and switches														
IPT101	IPT	Integrative Programming and Technologies 1	PF101 and PT101	3	LO1	Design, develop and test a program that uses a messaging service that sends asynchronous messages across the network	E	E		E	E	E	E							
					LO2	Design, develop and test a program that uses SAX or DOM to parse an XML document, XSL and XSLT to transform a data stream from one format to another														
					LO3	Write, debug and test a script using an operating scripting language to facilitate the management of an operating system														
IPT102	IPT	Integrative Programming and Technologies 2	IPT101	3	LO1	Compare and contrast the different encrypting and decrypting techniques that ensures security of data	E	E				E	E							
					LO2	Recommend where an application language and a scripting language would be more appropriate and give a valid reason to support the selection														

SIA101	SIA	Systems Integration and Architecture 1	IPT101	3	LO1	Analyze the appropriateness of a decision to in-source or out-source IT services in a given situation	E	E	E	E		E	E	E	E		E	E				
					LO2	Create a testing environment and design a stress test using appropriate tools and techniques that impact system performance																
					LO3	Implement an enterprise integration middleware platform.																
SIA102	SIA	Systems Integration and Architecture 2	SIA101	3	LO1	Summarize and analyze the data from a usability test and recommend appropriate actions.	E	E	E	E		E	E	E	E		E	E				
					LO2	Construct an architectural model of a complex system using an architectural framework																
					LO3	Develop a component and demonstrate its integration into an existing environment																
SP101	SP	Social and Professional Issues	At least Junior Standing	3	LO1	Argue the pros and cons of the design and implemention of computing solutions in various organizations								E	E	E	E	E	E			
SP102	SP	Social and Professional Issues 2	SP101	3	LO1	Analyze ethical and legal issues that arise in information technology field to determine how to address them technically and ethically			E					E	E	E	E	E	E			
IAS101	IAS	Information Assurance and Security 1	SIA101	3	LO1	Examine the relationship between threats, vulnerabilities, countermeasures, attackes, compromises and remediation throughout the entire system life cycle		E	E				E					E	E			
					LO2	Explain the key factors involved in authentication and how they are used to verify identity and grant access to the system																
					LO3	Describe the legal and ethical considerations related to the handling and management of enterprise information assets																

IAS102	IAS	Information Assurance and Security 2	IAS101	3	LO1	Discuss policies and practices to systems integration and architecture to ensure secure system operation and information assurance.		E	E			E	E				E	E		
					LO2	Perform a vulnerability analysis of a system and explain how design, implementation, and installation of hardware and software contribute to vulnerabilities of the organization.														
					LO3	Propose strategies on how to counter attack threats														
WS101	WS	Web Systems and Technologies 1		3	LO1	Develop Web applications using HTML, XHTML XML client-side programming and other Web GUI technologies to create and validate documents, generate contents via programming and integrate digital libraries with other media contents	E	E	E	E	E		E						E	
					LO2	Set up a web server to support server-side processing in a secure fashion and identify common server-side configuration issues that affect securing.														
WS102	WS	Web Systems and Technologies 2	WS101	3	LO1	Deploy and serve media contents within web applications	E	E	E	E	E		E					E	E	
					LO2	Implement a website and integrate it with other IT Applications														
					LO3	Propose possible improvements in the implemented web application to enhance security / avoid vulnerabilities														
CAP101		Capstone Project and Research 1	IAS101 CC106	3	LO1	Formulate the project objectives, scope and limitations, and evaluation metric	D	D	D	D			D	D	D	D	D	D	D	
					LO2	Collect and compare literature related to the project														
					LO3	Propose an ethical and feasible IT solution to the identified problems in the project														
CAP102		Capstone Project and Research 2	CAP101	3	LO1	Implement the proposed IT Solution	D	D			D	D	D	D	D	D	D	D	D	
					LO2	Evaluate and interpret the performance results of the IT solution based on identified evaluation metrics														

					LO3	Recommend possible improvements in the IT Solution due to implementation issues															
SA101	SA	Systems Administration and Maintenance	IAS102	3	LO1	Justify how resources will be allocated for the various administrative domains				D		D	D				D	D		
					LO2	Formulate policies governing the use of IT Systems within the organization															
					LO3	Recommend measures on how to administer and maintain systems effectively															
					LO4	Modify configuration of an operating system to implement policy															
PRAC101		Practicum	IAS 101 CC 106	3	LO1	Analyze, design, implement, test, maintain, and/or document a software system as applied to a real-world problem as part of a team in an actual company environment thereby also developing personal and interpersonal working skills in the process	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D

Section 11 Sample Means of Curriculum Delivery

The graduate outcomes of the BSCS, BSIS and BSIT curricula are achieved through, but not limited to the following activities:

1. Lecture and Classroom Discussions
2. Programming Demonstrations
3. Guided Hands-on Programming Sessions
4. Guided Design and Development of Project Specifications
5. Independent Programming Assignments such as Machine Problems
6. Case Analysis and Case Studies
7. Capstone Projects for BSIS and BSIT, which involves Requirements Gathering, Design, and Implementation
8. Thesis for BSCS
9. Mentorship and Monitored Internships

Section 12 Sample Syllabi for Selected Core Courses

INTRODUCTION TO COMPUTING

Prerequisite : None
Type of Course : Lecture
Units : 3

Course Description:

This course provides an overview of the Computing Industry and Computing profession, including Research and Applications in different fields; an Appreciation of Computing in different fields such as Biology, Sociology, Environment and Gaming; an Understanding of ACM Requirements; an Appreciation of the history of computing; and Knowledge of the Key Components of Computer Systems (Organization and Architecture), Malware, Computer Security, Internet and Internet protocols, HTML4/5 and CSS.

Learning Outcomes:

By the end of the course, students should be able to:

LO1. Explain fundamental principles, concepts and evolution of computing systems as they relate to different fields
LO2. Expound on the recent developments in the different computing knowledge areas
LO3. Analyze solutions employed by organizations to address different computing issues

Each of these LOs addresses the Degree Graduate Outcomes as follows:

- articulate and discuss the latest developments in the specific field of practice. (Philippine Qualifications Framework (PQF) level 6 descriptor) (Graduate Outcomes: CS10, IS10, IT13)
- effectively communicate orally and in writing using both English and Filipino (Graduate Outcomes: CS08, IS08, IT10)
- act in recognition of professional, social, and ethical responsibility (Graduate Outcomes:CS09, IS09, IT12)
- apply computing and other knowledge domains to address real-world problems (Graduate Outcomes: CS01, IS01, IT01)
- utilize modern computing tools (Graduate Outcomes: CS06, IS06, IT07)

Major Course Outputs:

As evidence of attaining the above learning outcomes, students are required to do and submit the following during the indicated dates of the term. The rubrics for these outputs are provided.

Learning Outcome	Required Output	Due Date
LO1/ LO2	MCO1: A case report on Information Technology best practices in various applications in IT industry.	
LO3	MCO2: Evaluation report on IT solutions employed by an organization covering various IT issues.	

Other Requirements and Assessments:

Aside from the major course outputs above, this course has one other summative assessment: a cumulative final exam. In addition, there are formative assessments of two types: departmental exams and graded class activities. Graded class activities include (but not limited to) recitation, seatwork, assignments and reports.

Grading System:

To pass this course, one must accumulate at least 60 points through the course requirements discussed above. The maximum points that a student can obtain through each requirement are shown below.

Requirement/Assessment Task	Maximum Points
2 Major Exams	20
Final Exam	15
Case Studies and Reports	50
Class participation, Seatwork	15
TOTAL	100

Learning Plan:

<table>
<tr><th>LO</th><th>Topics
and Readings</th><th>Class schedule
[Weeks]</th><th>Learning Activities</th></tr>
<tr><td rowspan="3">LO1</td><td>Industry in the Profession</td><td rowspan="3">Weeks 1 – 3</td><td rowspan="3">• Discussion should include (but not limited to) the following:
o professions and careers in the Computing field
o Computing domains
o Computing disciplines
o Computing Knowledge Areas
• Case Studies
• Reading Assignments</td></tr>
<tr><td>Appreciation of Computing in Different Fields</td></tr>
<tr><td>Different Specializations</td></tr>
<tr><td rowspan="7">LO2</td><td>Evolution of Computing</td><td>Week 4</td><td rowspan="7">Case Studies
Demonstration
Reading Assignments</td></tr>
<tr><td>Key Components of a Computer System, Operating Systems</td><td>Week 5-6</td></tr>
<tr><td colspan="2">• Exam 1
Information Technology concepts covering IT Professions and Careers, IT Domains and IT Disciplines, History of Computing, Computer System and Operating Systems</td></tr>
<tr><td>Malware</td><td>Week 7</td></tr>
<tr><td>Computer Security</td><td>Week 8</td></tr>
<tr><td>Networks, Internet and Internet Protocols</td><td>Weeks 9-10</td></tr>
<tr><td colspan="2">• Exam 2
Information Technology concepts covering Malware, Computer Security, Networks, Internet and Internet Protocols</td></tr>
</table>

LO	Topics and Readings	Class schedule [Weeks]	Learning Activities
	HTML and CSS	Weeks 11-12	
	Computer Systems (Organization and Architecture	Weeks 13-14	
	Final Exam		

Text / Materials :

References :

Cashman, S. & Vermaat, M.E. (2014). *Discovering Computers.* Cengage Learning

Note: Include books published in the last 3 years.

APPLICATIONS DEVELOPMENT AND EMERGING TECHNOLOGIES

Course Name : [CC106] Applications Development and Emerging Technologies
Course Credits : 3 units (2 units lecture, 1 unit laboratory)
Contact Hours : 5 hours / week (2 hours lecture, 3 hours laboratory)
Pre-Requisite : Computer Programming 2

Description : Development of applications using web, mobile, and emerging technologies with emphasis on requirements management, interface design, usability, testing, deployment, including ethical and legal considerations.

Learning Outcomes:

By the end of the course, students should be able to:

LO1. Develop specifications for a software development effort that precisely articulates the functional requirements, expected execution paths, and the explicit use of cutting edge or emerging technologies, which includes hardware devices and software library APIs.

LO2. Select and use a defined coding, documentation writing, and licensing standards in a sufficiently complex software project where coding idioms and mechanisms for implementing designs to achieve desired properties such as reliability, efficiency, and robustness are practiced with respect to legal and ethical considerations.

LO3. Undertake, as part of a team activity, an inspection of the source code and unit testing of the functional units of a sufficiently complex software project.

Course Outline:

1. Overview of software and hardware technologies
2. Requirements Analysis and Modeling
3. Design Principles and Patterns
4. Prototyping and Quality Assurance
5. Software Testing and Deployment
6. Ethical and Legal Considerations

Major Course Outputs:

As evidence of attaining the above learning outcomes, students are required to do and submit the following during the indicated dates of the term. The rubrics for these outputs are provided.

Learning Outcome	Required Output	Due Date
LO1	MCO1: A detailed specifications of a sufficiently complex software system that explicitly use cutting edge or emerging technologies. MCO2: A rigorous set of test data and sequence of input operations, expected results or program behavior, and the actual results or program behavior designed to comprehensively test the functional and operational aspects of the software project.	
LO2	MCO3: A documented evaluation and feedback on the software source code.	
LO3	MCO4: A documented evaluation of the software project with respect to software documentation, regression tests, and actual user feedback.	

Other Requirements and Assessments:

Presentations of the outputs are also required.

Grading System:

To pass this course, one must accumulate at least ___ points through the course requirements discussed above. The maximum points that a student can obtain through each requirement are shown below.

Requirement/Assessment Task	Maximum Points
Software Requirements, Design, and Execution Plan Software Implementation, Test, and Soft Deployment Class Presentations	
TOTAL	100

Learning Plan:

Note: The HEI may choose the cutting edge or emerging technology to use.

Rubrics:

Criteria	Exemplary 4	Acceptable 3	Developing 2	Beginning 1	No Output 0
Program Correctness	The application meets all the requirements specified in the project specification. The code is syntactically and logically correct for all cases. Implementation of the program follows the indicated guidelines and does not violate indicated restrictions. The implementation also exhibits appropriate use of programming constructs.	The code works for typical input, but fails for minor special cases; the major requirements are met, though some minor ones are not. Some Implementation of the program violates indicated restrictions.	The code sometimes fails or typical input. Many parts of the program Implementation violate indicated restrictions and some parts of the solution are not implemented using appropriate programming constructs.	The code often fails, even for typical input. Most indicated restrictions were violated.	Program that does not run and /or implemented incorrectly (based on specifications and restrictions) automatically gets 0 for this course output.
Effective Communication / Concept Understanding	Answers to questions are correct, reasonable, and reflective of the code. The justifications provided are sound.	Answers to questions are correct, but some justifications provided are weak.	Answers to questions are correct, but cannot justify solution (e.g., solution via trial and error, rather than proper understanding and application of concepts).	Correct understanding of the problem, but was unable to explain workings of code provided.	Failure to explain and justify workings of the code submitted will automatically merit 0 for this course output.
Readability	The program conforms to a coding standard that promotes code readability. Internal documentation is comprehensive.	Minor code formatting does not exhibit consistency in coding standard.	Not all functions / program features have proper internal documentation	Minimal internal documentation and code readability.	No internal documentation and code is not readable.

References :

1. Erich Gamma, Richard Helm, Ralph Johnson, and John Vlissides, Design Patterns: Elements of Reusable Object-Oriented Software, Addison-Wesley, 1994.
2. Stephen G. Kochan, Programming in Objective-C 2.0, Addison-Wesley, 2009
3. George Reese, Cloud Application Architectures: Building Applications and Infrastructure in the Cloud, O'Reilly Media, 2009.
4. Wei-Meng Lee, Beginning Android Tablet Application Development, Wrox, 2011.
5. Stephen Fishman JD, Legal Guide to Web and Software Development, Nolo, 2007.

Note: Include books published in the last 3 years.

Section 12 Sample Performance Indicators (rubrics-1 subject only)

Criteria	Exemplary 4	Acceptable 3	Developing 2	Beginning 1
Knowledge	Descriptions of scientific terms, facts, concepts, principles, theories and methods are complete and correct	Descriptions of scientific terms, facts, concepts, principles, theories and methods are mostly complete and correct	Descriptions of scientific terms, facts, concepts, principles, theories and methods are somewhat complete and correct.	Descriptions of scientific terms, facts, concepts, principles, theories and methods are minimally present or correct
Application	Applications are thorough, appropriate, and accurate.	Applications are mostly thorough, appropriate, and accurate.	Applications are somewhat, appropriate, and accurate.	Applications are minimally appropriate and accurate.
Communication	Some of the written, oral and/or visual communication is organized and effective	Some of the written, oral and/or visual communication is organized and effective	Some of the written, oral and/or visual communication is organized and effective.	Little of the written, oral and/or visual communication is organized and effective.

Source: http://www.isbe.net/ils/science/pdf/rubric.pdf

ARTICLE VI
REQUIRED RESOURCES

Section 13 Administration

13.1 Composition - A well-organized and competent staff and faculty shall administer the implementation of these programs and should meet the requirements set by the Commission.

13.2 A Higher Education Institution (HEI) offering any of these programs shall have a full time academic administrator for each program. This administrator can be a Dean, Department Head, Director, Coordinator or equivalent depending on the organizational structure of the HEI.

13.3 General Qualifications of the Program Administrator - The Administrator of these programs must possess any one of the following:

A. Bachelor of Science in Computer Science Program

a. Doctorate degree in Computer Science.

b. Master's degree in Computer Science, plus:

- at least three (3) years of CS work, CS consultancy, CS research experience, or tertiary level CS teaching experience, within the last five (5) years

c. At least a master's degree in a CS allied program plus:

- completion of Bachelor's degree in Computer Science; or
- completion of all coursework requirements for a master's degree in CS;

and

- at least three (3) years of CS work, CS consultancy, CS research experience, or tertiary level CS teaching experience, within the last five (5) years.

d. A doctorate degree in a CS allied program plus:

- at least ten (10) years of CS work, CS consultancy, CS research experience, or tertiary level CS teaching experience, within the last twelve (12) years.

B. Bachelor of Science in Information Systems and Bachelor of Science in Information Technology Programs

a. Doctorate degree in CS, IS, or IT.

b. Master's degree in CS, IS, or IT plus:

- at least three (3) years of computing work, computing consultancy, computing research experience, or tertiary level teaching experience in computing within the last five (5) years.

c. At least a master's degree in IS/IT allied programs, Engineering, or Mathematics plus:

- completion of Bachelor's degree in CS, IS, or IT; or
- coursework requirements for a master's degree in CS, IS, or IT;

and

- at least three (3) years of computing work, computing consultancy. computing research experience, or tertiary level teaching experience in computing within the last five (5) years.

d. A doctorate degree in IS/IT allied programs, Engineering, or Mathematics plus:

- at least ten (10) years of computing work, computing consultancy, computing research experience or tertiary level teaching experience in computing, within the last twelve (12) years;

13.4 General Functions and Responsibilities of the Program Administrator - The general functions and/or responsibilities of the Program Administrator should be as follow, thus:

13.4.1 To lead in strategic planning and management, including the formulation and implementation of the faculty development program;

13.4.2 To assist in the formulation of institutional policies;

13.4.3 To exercise overall supervision of all academic and non-academic personnel of the college or department;

13.4.4 To coordinate with the office concerned with student services;

13.4.5 To lead research and extension activities among faculty and students, including technology innovation and commercialization activities;

13.4.6 To oversee the formation, implementation and evaluation of plans and programs for development and the supervision/coordination of activities and services for the advancement of goals and objectives of the program;

13.4.7 To help enforce the concerned HEI's rules and the laws affecting education, and the procedures, policies, rules and regulations promulgated under authority of or as adopted by the Commission and/or the HEI;

13.4.8 To exercise educational leadership and accountability over the following:

13.4.8.1 assignment of academic load to faculty members, including appointment of faculty advisers;

13.4.8.2 appointment, promotion, retirement, termination of and disciplinary actions against faculty members and non-teaching personnel, subject to the HEI's policies and procedures;

13.4.9 To undertake periodic curriculum review, revision, and development with the assistance of the faculty members in the degree program concerned; and

13.4.10 To prepare course offerings, institute methodologies of instruction, adopt and recommend appropriate instructional and reference materials, and recommend books to add to the collection of the library.

13.4.11 To initiate and monitor development of academic and industrial linkages, extension and outreach programs, and career and internship placement programs;

13.4.12 To ensure the attainment of graduate outcomes through monitoring of graduates, and regular consultation with alumni and industry partners. This may be done through the creation of an industry advisory board.

Section 14 Faculty

14.1 Faculty Composition

14.1.1 There should be at least three (3) full time faculty members per program, one of whom could be the dean/program head/coordinator.

14.1.2 At least forty percent (40%) of CS, IS, and IT core and professional courses should be taught by full-time CS, IS, and IT faculty members. There shall be a career development and tenure track for full time faculty members.

14.1.3 For the Computer Science Program, at least sixty percent (60%) of CS professional courses should be taught by CS degree holders. At least thirty percent (30%) of all full-time CS faculty members should have a graduate degree in Computer Science.

14.1.4 For the Information Systems and Information Technology Programs, at least sixty percent (60%) of IS and IT professional courses should be taught by degree holders in either IS or IT program. At least thirty percent (30%) of all full-time IS and IT faculty members should have a graduate degree in either CS, IS or IT.

14.1.5 There shall be faculty members with industry experience within the last two (2) years. These may be full-time or part-time faculty members.

14.1.6 HEIs offering CS, IS or IT programs are strongly encouraged to have faculty members with doctorate degrees in CS, IS, IT or allied fields.

14.1.7 HEIs offering CS, IS or IT programs are strongly encouraged to have faculty members who actively do research and development work in CS, IS or IT, and who publish regularly in refereed journals and proceedings. Likewise, the faculty members are also encouraged to

join and actively participate in computing related professional organization(s).

14.2 Qualifications of Faculty

A. Bachelor of Science in Computer Science

A CS faculty should possess at least one (1) of the following qualifications:

14.2.1 At least a baccalaureate degree in CS, IS, or IT.

14.2.2 At least a baccalaureate degree in any allied program or at least a master's degree in a Science, Technology, Engineering, and Mathematics (STEM) field plus any of the following:

14.2.2.1 Completion of coursework requirements for a master's or doctorate degree in a CS program; or

14.2.2.2 At least three (3) years experience in the IT profession such as technical administration, systems design, applications programming or equivalent or computing research within the last 5 years.

14.2.3 At least a baccalaureate degree with an international IT certification to teach professional courses specific to that certification.

B. Bachelor of Science in Information Systems and Bachelor of Science in Information Technology

An IS or IT faculty should possess at least one (1) of the following qualifications:

14.2.1 At least a baccalaureate degree in CS, IS, or IT.

14.2.2 At least a baccalaureate degree in any allied program or at least a master's degree in a STEM field plus any of the following:

14.2.2.1 Completion of coursework requirements for a master's or doctorate degree in a CS, IS, or IT program.

14.2.2.2 At least three (3) years computing work or consultancy or computing research experience or tertiary level teaching experience in computing, within the last five (5) years

14.2.3 At least a master's degree in Accountancy, Business, and Management (ABM) program with adequate exposure to

computing through coursework or thesis/projects plus at least one of the following:

a. completion of coursework requirements for a master's degree in any computing program; or

b. at least three (3) years of computing work or consultancy or computing research experience or tertiary level teaching experience in computing, within the last five (5) years;

14.2.4 At least a baccalaureate degree with an international IT certification to teach professional courses specific to that certification.

14.2.5 Faculty members deemed to be qualified in an appropriate business program may teach business domain courses in the IS program within their specialization.

14.3 Load

14.3.1 Assignment - The regular load of a CS, IS, and IT faculty member is at most twenty-four (24) units or thirty (30) contact hours per week whichever is lesser, inclusive of lecture and laboratory. Overload should not exceed six (6) hours per week. There should not be more than four (4) preparations per term.

14.3.2 Teaching Load - As a general rule, in case the Dean has to teach, his or her teaching load should not exceed nine (9) contact hours per week. This load takes into consideration the functions of the Dean. For the department chair, his/her teaching load should not exceed twelve (12) contact hours.

14.3.3 Consultation Hours - Each full time faculty member shall render at least four (4) hours per week for student consultation. This should be outside of the regular contact hours.

14.4 Employment Status – A full-time faculty member should render at least twenty-four (24) hours in residence per week as certified by the HEI, have a minimum contract of one (1) year in the college/department and must not be employed full time elsewhere.

14.5 Faculty Support

14.5.1 Faculty Development Program - The college/department should have a written comprehensive faculty development program. There shall be a specific budget allocation to implement such program. HEIs are enjoined to send full-time faculty members to participate in various activities of computing professional organizations. There shall also be clear guidelines on ranking and promotion of faculty members up to professor level.

14.5.2 Facilities - The HEI should provide office space, computers with Internet connections and printers for faculty and administrators. There should be one (1) computer for every three (3) full-time equivalent faculty members

and one (1) for every administrator. Consultation areas for student and faculty are also required.

Section 15 Library

15.1 Librarian(s) - HEIs offering the CS, IS, and IT programs should have at least one (1) full-time licensed librarian with at least one (1) year appointment. The librarian(s) shall participate in faculty meetings and activities and serve as (a) member(s) of the educational program planning committee. The librarian(s) should work closely with the Dean or Department Chair in collection development for the CS, IS, and IT programs.

The librarian(s) should be encouraged to join recognized librarian societies and associations for professional development.

There should be at least one (1) librarian/staff for every five hundred (500) students or fraction thereof.

15.2 Book Collection. - The library collection of the HEI should meet the following requirements, namely:

15.2.1 To support HEI's curricular needs and to provide enough books for students, its library should have at least five (5) titles per professional course, at least one (1) of which has been published within the last five (5) years. The total number of volumes per course should be such that, there should be one (1) volume for every ten (10) students enrolled (e.g. if there are 100 students enrolled in the course Introduction to Computing, then there should be 10 volumes of books on Introduction to Computing of which 5 titles should be distinct). Book holdings should preferably include more reference books and textbooks rather than vendor specific technology books. e-Books should also be counted to satisfy this requirement.

15.2.2 For initial offering, the minimum volumes of books covering first to third year courses are required to be found in the library. For program recognition, an HEI should have the required number of books in all four-year levels.

15.2.3 The library should include significant holdings of up-to-date computer magazines, journals and periodicals that are published locally and internationally. These include at least two (2) publications per program. The HEI should have current subscription to the journals and magazines. Paid online / digital subscriptions to at least twenty (20) journal titles are allowed as substitute for journals and magazines provided that they can be readily accessed and printed by faculty, students and staff.

15.2.4 The library must provide Internet terminals for access to electronic materials.

15.2.5 The library must provide access (with capability to read or print) to electronic library materials such as CD-ROMs and electronic subscriptions. These are considered as additional library holdings beyond the minimum requirements.

15.2.6 The library facilities may be augmented by providing Learning Commons.

15.3 Space Requirements. - The library should have a seating capacity of at least five percent (5%) of the total students enrolled and a minimum floor area of at least two (2) sqm per seat. This may include spaces provided as Learning Commons.

Section 16 Laboratory and Physical Facilities

16.1 **Classroom Requirements**. There should be at least one classroom per one hundred fifty (150) students enrolled. Preferably, there should be no more than 50 students in a class. In case of large classes with more than 50 students, preferably, there should be separate discussion classes with at most 50 students each.

16.2 **Laboratory Requirements**. The number of terminals dedicated for computing students should be at least 1/5 of the total number of computing students. This is to allow each student to have enough individual hands-on computer time per week. The computer-to-student ratio in a laboratory class should be 1:1.

In addition to teaching facilities, the HEI must provide internet access for the students and faculty members. All computer laboratories must have Internet Access. The minimum dedicated bandwidth must be at least 4Mbps. There should be at least 4Mbps per 500 students. Students must also have access to wifi and to a learning management system.

The required computer hardware and software should be able to respond to the objectives of the courses in the curriculum. They should conform to generally accepted industry standards and be capable of providing training in multiple platforms. There should also be equipment for courses that require specific hardware such as routers and switches. Only licensed software, including free and open source software, may be installed.

16.3 **Audio Visual Facilities.** Every laboratory must be equipped with projection equipment or large display to demonstrate digital content. In addition, projectors must also be available for use in lecture rooms. Large lecture halls must be equipped with sound systems.

ARTICLE VII
COMPLIANCE OF HEIs

Using the **CHED Implementation Handbook for OBE and ISA** as reference, a HEI shall develop the following items which will be submitted to CHED when they apply for a permit for a new program or the approval of the transformation of existing programs to outcomes-based framework:

Section 17 The complete set of program outcomes, including its proposed additional program outcomes.

Section 18 Its proposed **curriculum** and its justification including a curriculum map.

Section 19 Proposed **performance indicators** for each outcome. Proposed measurement system for the level of attainment of each indicator.

Section 20 Proposed **outcomes-based syllabus** for each course.

Section 21 Proposed system of program assessment and evaluation

Section 22 Proposed system of program **Continuous Quality Improvement (CQI).**

ARTICLE VIII
PROVISIONS FOR K-12 IMPLEMENTATION

Section 23 Revised General Education (GE)

When the new GE curriculum will take effect in AY 2018-2019, as provided in CMO 20, s. 2013 entitled "General Education Curriculum: Holistic Understandings, Intellectual and Civic Competencies", the 54 units GE requirements will be reduced to a minimum of 36 units.

The balance of 18 units may be replaced by professional/ domain courses in each of the three (3) programs (CS, IS and IT) as long as the minimum total number of units is satisfied as articulated in Section 8.1.

ARTICLE IX
TRANSITORY, REPEALING AND EFFECTIVITY CLAUSE

Section 24 Transitory Provision

HEIs that have been granted permit or recognition are hereby given one (1) year from the date of effectivity hereof to fully comply with all the requirements as stipulated in this CMO, including both the changes to the new curriculum and transformation to OBE. Compliance to these requirements shall also be required to State Universities and Colleges (SUCs) and Local Colleges and Universities (LCUs).

Section 25 Repealing Clause

All pertinent rules and regulations or parts thereof that are inconsistent with the provisions of these policies, standards, and guidelines are hereby repealed or modified accordingly.

Section 26 Effectivity Clause

This CMO shall be effective beginning SY 2016-2017 after publication in the Official Gazette or in a newspaper of general circulation.

Quezon City, Philippines, August 3, 2015

FOR THE COMMISSION:

PATRICIA B. LICUANAN, Ph.D.
Chairperson

ANNEX A

GUIDELINES

UNDERGRADUATETHESIS / CAPSTONE PROJECTS FOR COMPUTING PROGRAMS

X----------X

ARTICLE I
INTRODUCTION

Section 1 Rationale and Background

The Commission on Higher Education has approved programs for Computer Science, Information Technology and Information Systems. These shall henceforth be referred to as Computing Programs. This shall also include any programs that may be endorsed by the Technical Panel for Information Technology Education (TPITE), and subsequently approved by CHED.

The Thesis / Capstone Project are required for candidates for graduation in all Computing Programs. Both the thesis and capstone projects are terminal project requirements that would not only demonstrate a student's comprehensive knowledge of the area of study and research methods used but also allow them to apply the concepts and methods to a specific problem in their area of specialization.

BS Computer Science students are required to complete a thesis that is focused on the theories and concepts of computing in the form of a scientific work.

BS Information Systems students must complete a project in the form of a business application development, or an Information Systems plan.

BS Information Technology students must complete a capstone project in the form of an IT application, a Multimedia Systems development, or an IT Management project.

It is expressly understood that Computing Thesis and Capstone projects need not require surveys, statistics, and descriptive methods, unless appropriate.

HEIs are required to include thesis and capstone projects in their curricula. The Policies and Standards for Undergraduate Thesis intends to serve as a guide for administrators, faculty and students

alike in determining what are allowable standards or capstone projects in the context of undergraduate studies in Computing.

ARTICLE II
THESIS / CAPSTONE PROJECTS SPECIFICATIONS

Section 2 Definitions

2.1 A **Thesis** is a technical report on a systematic investigation of a problem that can be solved using Computing. It may include a solution, an approximate or partial solution, a scientific investigation, or the development of results leading to the solution of the problem.

2.1.1 A Computer Science thesis must be anchored on Computer Science principles.

2.2 A **Capstone Project** is an undertaking appropriate to a professional field. It should significantly address an existing problem or need.

2.2.1 An Information Technology Capstone Project focuses on the infrastructure, application, or processes involved in introducing a Computing solution to a problem.

2.2.2 An Information Systems Capstone Project focuses on business processes and the implications of introducing a Computing solution to a problem.

Section 3 Scope of the Theses / Capstone Projects

The Thesis or Capstone Project should integrate the different courses, knowledge, and competencies learned in the curriculum. Students are encouraged to produce innovative results, generate new knowledge or theories, or explore new frontiers of knowledge or application areas.

For Computer Science, theses involving the development of the software systems should involve algorithm-based research and development founded on Computer Science principles. This should be reflected in the final report.

For Information Technology Capstone Projects, recommended infrastructure and its implications on other systems should be clearly specified in the final report with the introduction of the project.

For Information Systems Capstone Projects, changes in process and information flow and/or information policies with the introduction of the system should be clearly specified in the final report.

The thesis/capstone project adviser should determine the appropriate complexity level of the specific problem being addressed and the proposed solution, considering the duration of the project, the composition of the team, and the resources available.

Section 4 Suggested Areas for Theses / Capstone Projects

Following is a list of some suggested areas per program. The specific areas identified for each degree program may also be considered for the other computing degree programs, depending on the scope, limitations, and approach and following the principles stated in preceding sections.

4.1 Computer Science

4.1.1 Current Computer Science Topics

- Software Development and Theory
- Mobile Computing Systems
- Software Extensions or Plug-ins
- Expert Systems and Decision Support Systems
- Systems Software (software tools/utilities, interpreters, simulators, compilers, security aspects)
- Intelligent Systems
- Game Development
- Computer Vision
- Image / Signal Processing
- Natural Language Processing
- Pattern Recognition and Data Mining
- Bioinformatics
- Graphics Applications
- Cloud Computing
- Parallel Computing
- Embedded Systems
- Emerging Technologies

4.1.2 Foundations of Computer Science

- Automata and Formal Languages
- Data Structures and Algorithm Design and Analysis
- Web Semantics
- Coding Theory
- Programming Languages
- Visualization Systems
- Computer and Architecture
- Modeling and Simulation

4.1.3 Human-Computer Interaction

- Usability
- Affective Computing
- Emphatic Computing

4.2 Information Systems

4.3.1. Software Development

- Software Customization
- Information Systems development for actual client
- Web Applications Development
- Mobile Computing Systems

4.3.2. IS Planning

- Enterprise Resource Plan
- Information Systems Strategic Plan

4.3.3. Analysis and Design of a sufficiently complex business system

4.3 Information Technology

4.2.1 Software Development

- Software Customization
- Information Systems Development for an actual client (with pilot testing)
- Web Applications Development (with at least alpha testing on live servers)
- Mobile Computing Systems

4.2.2 Multimedia Systems

- Game Development
- e-Learning Systems
- Interactive Systems
- Information Kiosks

4.2.3. Network Design and Implementation and Server Farm Configuration and Management

4.2.4. IT Management

- IT Strategic Plan for sufficiently complex enterprises
- IT Security Analysis, Planning and Implementation

Section 5 Thesis / Project Duration

Students should be given ample time to finish their project. Two (2) to three (3) terms or semesters should be prescribed in the curriculum for BS Computer Science students to complete their theses and one (1) to three (3) terms or semesters for BS Information Technology and BS in Information Systems students to complete their Capstone Projects.

The maximum number of units that may be required for Thesis or Capstone Projects is nine (9) units.

Grading systems and possible honoraria rates for thesis/capstone project are left to the discretion of the HEI, provided that such policies are not grossly disadvantageous to the students, and provided further that such policies are documented and approved by the proper HEI authorities.

Section 6 Composition of Thesis / Project Groups

Students should preferably work in teams of two (2) to four (4) members depending on the complexity of the project. The adviser should be able to determine whether the team can complete the project on time.

Multidisciplinary teams are also encouraged, provided that team members prepare separate documentations per program.

Section 7 Adviser / Panel Composition

7.1 Panel Composition

The project is prepared under the guidance of an adviser and presented and accepted by a Panel composed of at least 3 members that includes the adviser.

7.2 Adviser / Panel Qualifications

The adviser must have completed a computing project successfully beyond the bachelor's degree project. As much as possible, the adviser should be a full-time faculty member of the HEI. Otherwise a full-time faculty co-adviser is required.

Advisers and Panel Members should have a degree in a Computing or allied programs, or must be domain experts in the area of study. At least one of the panel members must have a master's degree in Computing (preferably in the same field as

the thesis or project) or allied program. For IT and IS, at least one of the panel members should preferably have industry experience.

The adviser must be able to guide the students throughout the whole project life cycle, including the thesis/capstone project defense and possible project deployment.

Faculty advisers should preferably handle at most five projects at one time, and in no case should exceed ten (10) projects. Panel members should preferably be limited to at most ten (10) projects and in no case should this exceed twenty projects in one semester, counting all projects in all HEIs.

In case of the participation of an external client, then the organization for which the project is intended should be represented as much as possible.

Section 8 Presentation of the Thesis or capstone Projects

Thesis and Capstone project must be presented in a public forum. This forum may be an international, national, regional, or school-based conference, meeting, or seminar that is announced and open to interested parties. This may be separate from the presentation before the Panel mentioned in Section 6. A school-based colloquium organized for this purpose would suffice to satisfy this requirement. Presentation in a public forum, such as the National Conference on IT Education (NCITE) of PSITE, is encouraged.

ARTICLE III
THE THESIS / PROJECT FORMAT

Section 9 Suggested Documentation Template / Format

Upon completion of the Thesis or Capstone Project, the students shall be required to submit copies of documentation of their work by team. This may be in the form of a research report in journal article format such as ACM or IEEE Format, a bound technical report, or comprehensive electronic documentation. The format is left to the discretion of the HEI.

9.1. Computer Science Thesis

9.1.1. Sample Outline for Thesis involving Foundations of Computer Science

Title Page
Abstract

Table of Contents
List of Figures, List of Tables, List of Notations
Introduction
- Background of the problem
- Statement of the problem
- Objectives
- Significance

Scope and Limitations
Related Literature
Theoretical Background
- include comprehensive discussion on theorems, definitions, fundamental algorithms , mathematical models/formula

Proposed Solution to the Problem
Results and Discussion, includes theoretical proof, verification, or evidence
Conclusions and Recommendations

Appendices may include the following
- Relevant Source Code, where applicable
- Source Data, where applicable
- One-page Curriculum Vitae per team member

9.1.2. Sample Outline for Thesis involving Software Development

Title Page
Abstract or Executive Summary
Table of Contents
List of Figures, List of Tables, List of Notations
Introduction
- Project Context
- Purpose and Description
- Objectives
- Scope and limitations

Related Literature
Technical Background
- Include in-depth discussion on relevant technical aspects of the project

Design and Methodology
- Include discussion on conceptual design / system architecture/ block diagrams and algorithms

Results and Discussion
Conclusions and Recommendations

Appendices may include the following
- Relevant Source Code
- Evaluation Tool or Test Documents
- Sample input/output/Reports

- Users Guide
- One-Page Curriculum Vitae per team member

9.1.3. ACM Journal Article Format

9.2. Information Technology and Information Systems Capstone Projects

9.2.1 Sample Outline for IS Plans

The IS Plan may follow any of the established frameworks, such as that of the National Computer Center.

9.2.2 Sample Outline for Capstone Projects

Title Page
Executive Summary
Table of Contents
List of Figures, List of Tables, List of Notations
Introduction
- Project Context
- Purpose and Description
- Objectives
- Scope and limitations

Review of Related Literature/Systems
Technical Background
Methodology, Results and Discussion
- Requirements Analysis
- Requirements Documentation
- Design of Software, Systems, Product, and/or Processes
- Development and Testing, where applicable
- Description of the Prototype, where applicable
- Implementation Plan (Infrastructure/Deployment) where needed
- Implementation Results, where applicable

Recommendations

Appendices may include the following
- Relevant Source Code
- Evaluation Tool or Test Documents
- Sample input/output/Reports
- Users Guide
- Process/Data/Information Flow
- Screen layouts
- Test Results
- Sample Generated Outputs
- Pictures showcasing the data gathering, investigation done (e.g. floor plan, layout, building, etc.)
- One-Page Curriculum Vitae per team member

ARTICLE IV
INTELLECTUAL PROPERTY RIGHTS

Section 10 Intellectual Property (IP) Rights

All Thesis and Projects must not infringe on existing IP. All prior works, including open source, open content, and creative commons content, shall be properly cited.

Copyright and other Intellectual Property Rights arising from the Thesis or Capstone Project shall be bound by the IP Policies of the HEI, provided that any such policies shall not be grossly disadvantageous to the creators of IP.

Appendix B

BU Thematic Area: Global Competitiveness of Business and Industry

Proposed Title: Barangay Centro Occidental E-blotter Management System

Rationale:

The barangay is the smallest political unit in the Philippines. Each municipality or city is made up of barangays. For a small unit of government, the barangay structure is not a simple one. It has an elected Punong Barangay, a Sangguniang Barangay consisting of seven elected members and the Sangguniang Kabataan Chairman, and a separate appointive secretary and an appointive treasurer – altogether 11 barangay officials.

In this context, Transaction Processing System (TPS) can be implemented to a barangay hall that will provide an efficient transmission in terms of recording and monitoring documents. Transaction Processing System (TPS) is a system that collects, stores, modifies, and retrieves data transaction of an organization. It was designed to process day to day transactions. It seeks time and cost efficiency by automating repetitive operations.

In this study, the researchers aim to develop a system entitled, “Barangay Centro Occidental E-blotter Management System”. It will provide an automated system to lessen the manual process in the barangay in the filling of blotter report and issuance of requested documents.

Objectives of the Study:

The study aimed to develop an E-blotter Management System for Barangay Centro Occidental that automates the manual process of monitoring and recording of documents. Specifically, it aims to:

1. Determine the problems encountered of Barangay Centro Occidental in terms of: a.) blotter reports b.) barangay documents and c.) barangay information and activities;
2. Design and develop a stand-alone system that is fully automated and user-friendly to the users; and
3. Evaluate the proposed system in terms of functionality, reliability and usability.

Methodology:

The researchers will use the Rapid Application Development Method (RAD). Rapid Application Development is a methodology that enables organizations to develop strategically important systems faster while reducing development costs and maintaining quality. This is achieved by using a series of proven application development techniques, within a well-defined methodology. It consists of a short development cycle based on four (4) phases namely: Requirements Planning, User Design, Construction, and Cutover.

Expected Output:

The proposed study will have a user-friendly graphical user interface (GUI) to be easily understood by the users which is fully automated system, time effective and efficient. It will minimize all the paper works and manual records keeping in the barangay because there is a database that will served as their storage, therefore allowing the barangay officials ease in keeping track of the important documents, reducing the constituents' waiting time in getting barangay documents and increasing the number of people to be served. The process will be fast and convenient not only to the barangay officials who will use it but also to the complainants and constituents in the barangay.

Prepared by:

CAMEL ELLA B. CALITISIN
BSIS Student

RACHEL ANN V. VELASQUEZ
BSIS Student

STEPHEN ALEC SAYSON
BSIS Student

Noted by:

MARIA CHARMY A. ARISPE, MSME, MIT
Capstone Project Adviser

Appendix C

BUPC UNDERGRADUATE THESIS FORMAT GUIDELINES

Prepared by:
FLORADEL S. RELUCIO, MIT
College Research Coordinator

THESIS FORMAT

A. Title Page

DEVELOPMENT OF A MICROPROCESSOR-BASED AUTOMATED BEVERAGE MIXER

Font 12, Bold Inverted Pyramid, Times New Roman

An Undergraduate Thesis Presented to the Faculty of
Computer and Engineering Studies Department
Bicol University Polangui Campus
Polangui, Albay

Font 12, Bold Inverted Pyramid, Times New Roman

In Partial Fulfillment of the Requirements for the Degree
Bachelor of Science in Computer Engineering

Font 12, Bold Inverted Pyramid, Times New Roman

Relucio, Floradel S.

March 2018

B. TABLE OF CONTENTS FORMAT

Font 12

TABLE OF CONTENTS

Note: BIBLIOGRAPHY - usually in alphabetical listing of source materials. (Arrange in alphabetical order),

- *Kindly refer to the Citation Style of the American Psychological Association (APA) Discussed by: Gremil Alessandro Alcazar Naz, MPSDC, MAMCC*
- *For more information, go to **www.apastyle.org***

LIST OF TABLES

Note:
1. Align properly the page numbers
2. List of tables and list of figures are placed on separate pages

LIST OF FIGURES

Note:
1. Align properly the page numbers
2. List of tables and list of figures are placed on separate pages

GENERAL THESIS FORMAT GUIDELINES

General Document Guidelines

A. ***Margins****:* 1.50 inch left margin , One inch on the remaining sides (top, bottom, right)

B. ***Font Size and Type****:* Times New Roman, size 12;

C. ***Line Spacing****: 2.00* space throughout the paper, including the title page, body of the document, references, appendices, notes, tables, and figures.

D. ***Spacing after Punctuation****:* Space *once* after commas, colons, and semicolons within sentences.

E. ***Alignment****:* Justified

F. ***Pagination****:* All pages of the text of a thesis should be numbered, including the first page. Position numerals in the upper right-hand corner one inch from the top of the page, flush with the right margin. Double space to the first line of the text. Preliminaries use lower case roman numerals and place at the center, lower bottom.

G. ***Table of contents****:* Words designating elements of the paper, such as the preface and bibliography, should be typed in uppercase letters. Indent one-digit chapter number five spaces, and position numbers of two digits or more by aligning the numerals I the right-hand column. The wording, capitalization and punctuation of titles and heading should be typed exactly as they appear in the text. Headings, and subheadings underlined in the text should not be underlined in the table of contents. Use a two-hanging indention (that is, the first line at the margin and subsequent lines indented) within headings and between successive levels.

H. ***Abstract.*** The abstract should consist of 250-300words.

I. ***Captions.*** Each **table** must have a caption, or title, that tells concisely and clearly what the table contains. It should be a descriptive phrase. Place the caption above the table. Each **figure** must have a caption, or title that tells concisely and clearly what the figure contains. Caption should be placed below the figure.

Table and Figures format:

Table 1. Name of the table in Times New Roman, size 12, regular, left aligned

Column 1	Column 2*	Column 3
First row column 1 entry	First row column 2 entry	First row column 3 entry
Second row column 1 entry	Second row column 2 entry	Second row column 3 entry
Third row column 1 entry	Third row column 2 entry	Third row column 3 entry
Fourth row column 1 entry	Fourth row column 2 entry	Fourth row column 3 entry

**Column 2 legend*

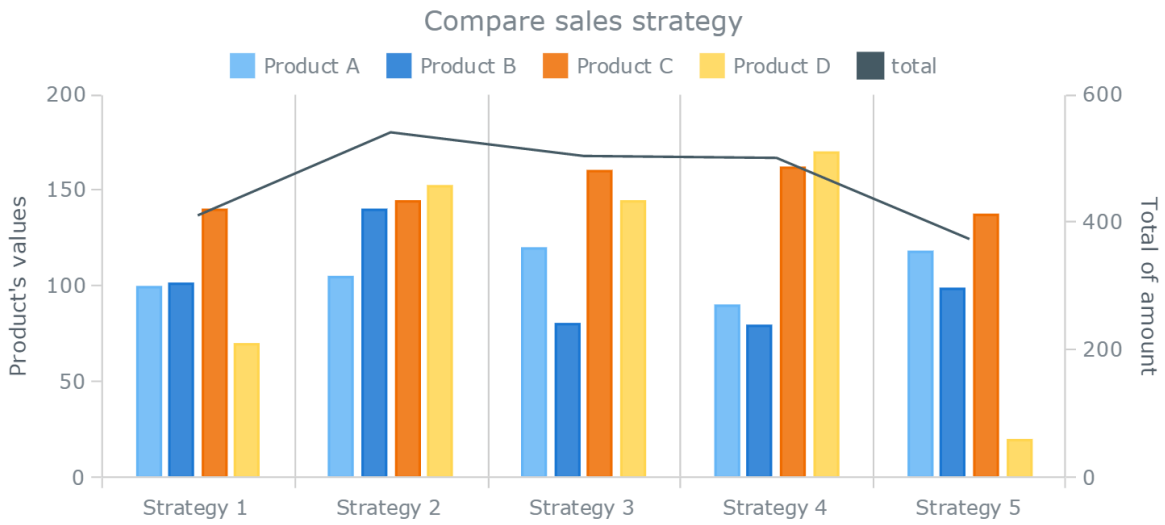


Figure 1. Title of figure 1 in Times new roman, size 12, center-aligned

ABSTRACT

(Times new roman, 12, Bold, Left, UPPERCASE)
<one single space>

The abstract should be typed in Times New Roman-regular, font size 12, with ½ inch left indention and justified in one paragraph only. The abstract shall be limited from 250-300 words only. It should contain the objectives, methodology and the salient findings conclusions.

<one single space>

Keywords: *keyword1, keyword2, keyword3, keyword4, keyword5*
(Keywords may include 4-5 words separated by commas, font size 12, Times new roman, italics, and left-aligned with no indention).

Introduction

(Headings must be in Times new roman, font size 12, left-aligned and uppercase/lowercase)
<one single space>

The body shall be in Times New Roman-regular, size 12, ½ inch first line indention each paragraph and left-justified. The headings of each section shall be indicated in the following order.

<one single space AFTER EACH paragraph>
<one double space after last paragraph>

Conceptual/Theoretical Framework

(Headings must be in Times new roman, font size 12, left-aligned and uppercase/lowercase)

Methodology

(Headings must be in Times new roman, font size 12, left-aligned and uppercase/lowercase)

Results and Discussion

(Headings must be in Times new roman, font size 12, left-aligned and uppercase/lowercase)

<one single space>

Discussion 1

(in case of sub discussions, sub-headings must be in Times New Roman-regular, size 12, italics, left aligned)

<one single space before 1st paragraph and one single space after each paragraph>
<one double space after last paragraph>

Conclusion

(Headings must be in Times new roman, font size 12, left-aligned and uppercase/lowercase)

References

(References shall follow the APA format)

- Kindly refer to the Citation Style of the American Psychological Association (APA) Discussed by: Gremil Alessandro Alcazar Naz, MPSDC, MAMCC
- For more information, go to **www.apastyle.org**
- The reference list ("Reference List" or "References") arranges alphabetically all works cited in a hanging indent style.

Researcher's Profile

(Last name, Given Name, and MI is the format of the name followed by academic information and other details ranging from 50 to 60 words only)

NOTE: *The same format applies to other sections.*

ROLES AND RESPONSIBILITIES OF THE THESIS ADVISORY COMMITTEE

ADVISER

- The adviser must come preferably from the faculty of the Department where the student belongs and must be chosen according to the following criteria:

  PROGRAM: Experience in the Research area/field of specialization
  ADVISEE: Advising load must not exceed from five (5) active advisees per semester
  RAPPORT: Must have established good rapport with advisee
  TIME: Must have enough time for advising

QUALIFICATIONS OF THE ADVISER

- A research adviser should be deemed qualified if he/she is:
  a. A researcher recognized by the institution, masters/doctoral degree holder, writer of his/her own study and participant to previous research trainings and seminars sponsored by CHED and the University/ College;
  b. A full-time faculty member undergoing research within his/her specialization; and/or
  c. An actual researcher and an adviser to advisee's not exceeding ten (10) in number within a given academic year in an institution where he is connected.

DUTIES AND RESPONSIBILITIES

The Adviser shall:

1. Draft a schedule of activities in behalf of the advisee's professionalization.
2. Keep a log plan of advising with conference notes duly recorded.
3. Safeguard the integrity of the advisee's work by checking each part thoroughly for possible duplication with other sources thus avoid plagiarism.
4. Refrain from accepting a finished product from the advisee by encouraging him/her to submit drafts in his/her own handwriting.
5. Demonstrate fairness towards the advisee to boost his/her morale efforts since research is the advisee's scholastic reflection of his/her ideas, creativity and style.
6. Cultivate desirable attitudes such as openness, flexibility, patience and tolerance to inspire and draw out advisee's enthusiasm and determination in writing.
7. Recommended the advisee's oral defense as well as certify to his/her readiness after a scrutiny of the research style and standard.
8. Sit with the advisee on two (2) oral examinations: *Proposal and Final Defense*.
9. Observe professionalism during defense and for the whole duration of the conduct of the thesis.
10. Act as a Mediator between the panel of evaluators and the advisee.
11. Act as a Secretary during proposal and final defense.

THE THESIS EVALUATION COMMITTEE

PROPOSAL DEFENSE	FINAL DEFENSE
- Qualified Faculty as chairperson	- Qualified Faculty as chairperson
- Specialist on topic/ field as first member	- Specialist on topic/ field as first member
- Statistician/research expert/ research Instructor as second member	- Statistician/research expert/ research Instructor as second member
	- Presence of another faculty or any qualified external evaluator as chairman or member (optional)

DUTIES AND RESPONSIBILITIES OF THE EVALUATION COMMITTEE

PANEL CHAIRMAN

QUALIFICATIONS OF THE PANEL CHAIRMAN:

- A Panel Chair should be deemed qualified if he/she is:
  a. A researcher recognized by the institution, masters/doctoral degree holder, writer of his/her own study and participant to previous research trainings and seminars sponsored by CHED and the University/ College;
  b. A full-time faculty member undergoing research within his/her specialization; and/or
  c. An actual researcher and chairman of the thesis evaluation committee not exceeding five (5) in number per program for a semester in an institution where he is connected.

The Panel Chair:

- Conducts the oral examination period within one (1) but not exceeding three (3) hours in a manner where the academic integrity of the research inquiry is maintained;
- At the adviser's request, calls for a recess or suspension of the defense if the conduct of the defense is unfavorable to the candidate.
- Reviews and summarizes the grades of the individual panelists and announces oral examination results
- Provides the members with the list of suggestions and recommendations made during the defense within three days of the activity.
- Submits approval sheets and other pertinent documents duly signed by the members to the Department Chairman, through the research professor or department focal person.
- Appraise the validity and acceptability of the thesis work in terms of its scholarly quality, correctness of the facts and claims contained therein; and completeness as to its basic components.
- Make sure that all suggestions are judiciously incorporated,
- Evaluate the research report based on the adopted criteria, and
- Be physically present during the proposal and final defense.

PANEL MEMBERS

QUALIFICATIONS OF THE PANEL MEMBERS:

- A Panel Member should be deemed qualified if he/she is:
  a. researcher recognized by the institution, masters/doctoral degree holder, writer of his/her own study and participant to previous research trainings and seminars sponsored by CHED and the University/ College;
  b. A full-time/part-time faculty member undergoing research within his/her specialization; and/or
  c. An actual researcher and a member of the thesis evaluation committee not exceeding five (5) in number per program for a semester in an institution where he is connected.

Panel Members:

- Appraise the validity and acceptability of the thesis work in terms of its scholarly quality, correctness of the facts and claims contained therein; and completeness as to its basic components.
- Make sure that all suggestions are judiciously incorporated,
- Evaluate the research report based on the adopted criteria, and
- Be physically present during the proposal and final defense.

PRELIMINARY ORIENTATION OF THE PANEL, EXAMINEE AND ADVISER

- Introduction of the members of the panel
- Information on the purpose of the Oral Examination
  - To ascertain the mastery of the examinee of the research skills

PROCEDURE IN THE ORAL EXAMINATION

- The oral examination shall be conducted in not more than three hours. This shall be conducted in a manner where the integrity of the research inquiry is maintained and sustained. This time frame, however, includes the preliminary and synthesis portions of the examination, i.e. grading and announcement of the examination results.
- The first twenty minutes will be devoted to general information particularly on current issues, which may or may not have bearing on the content of the thesis.
- The next one hour will be the EXAMINATION PROPER on the content of the manuscript. The academic dialogue must bring about in the examinee, his/her mastery of the research inquiry through a coherent and logical presentation of the problem and his/her attempts at answering them. He/She should be allowed to argue his/her case by convincingly articulating his/her ideas with intellectual honesty and humility.
- The panelist is requested to limit his/her questions on the subject under study and/or relevance of the results of other fields. The focus of the whole dialogue is on content or substance under study, rather than the form or style of the manuscript.
- While the adviser is requested to refrain from answering for the examinee, he/she may recast the question of the panelist for the benefit of his/her advisee.

DEFENSE PROPER

- The Adviser is requested to introduce his/her advisee.
- He/She should turn over the table to the committee chair.
- He/She should request the examinee to give 5-10 minutes resume of the whole study.
- Reminders are as follows:
    - He/She should accept the decision of the panel; and
    - In case or reasonable doubt on the results of the oral defense, the examinee may, within two weeks, request for reconsideration, in which case, another panel may be formed to review the paper or to recognize another oral defense which will be acceptable to all concerned.
- The oral examination will be guided with the prescribed BUPC rating sheet from the specific Department.
- Defense must be scheduled Mondays to Fridays only.

- The purpose of the Oral Examination is to ascertain mastery of the examinee of the research skills and NOT to trap the dialogue with the examinee, the adviser, and the members of the evaluation committee.
- To realize this purpose, the Oral Examination shall be conducted in an atmosphere befitting the professionalism of the situation. This academic atmosphere implies preparation of the panelist by reading the manuscript (in advance) and orientation along the purpose of the aforementioned examination.

Note: *NO Adviser, NO Panel Chairman, NO Defense*
All Defense should be done within the Campus.

MANUSCRIPT EDITORS OF RESEARCH STUDIES

QUALIFICATIONS:

An Editor must be a researcher, with Bachelor's degree major in English or any relevant discipline, a masters/doctoral degree holder either full-time or part-time faculty member of the University.

Roles/Responsibilities of Manuscript Editors of Research Studies

1. Must follow the prescribed format of each program that will be provided by the researcher/s of the study.
2. Must proof read the following:
    a. Grammar/sentence structure of the study
    b. In the technical part, he must call the attention of the researcher/s or the adviser if there are some clarifications to be made.
    c. If the editor wants to change anything on the content of the paper, he must first ask the consent of the panel of evaluators since it already passed during the defense.

3. Can accept a hardcopy or e-copy of the manuscript, which is convenient on the part of the editor.
4. Give acknowledgement receipt to the researcher/s as proof of acceptance of the manuscript and that they will be given three to four days to edit or review the paper.
5. Editors have the right to decline or refuse to accept a manuscript for some valid reasons.
6. Editors are entitled to an honorarium that will be given by the researcher/s which will not exceed to the amount of **Php 500.00** per study upon receipt of the edited manuscript of the researcher/s.

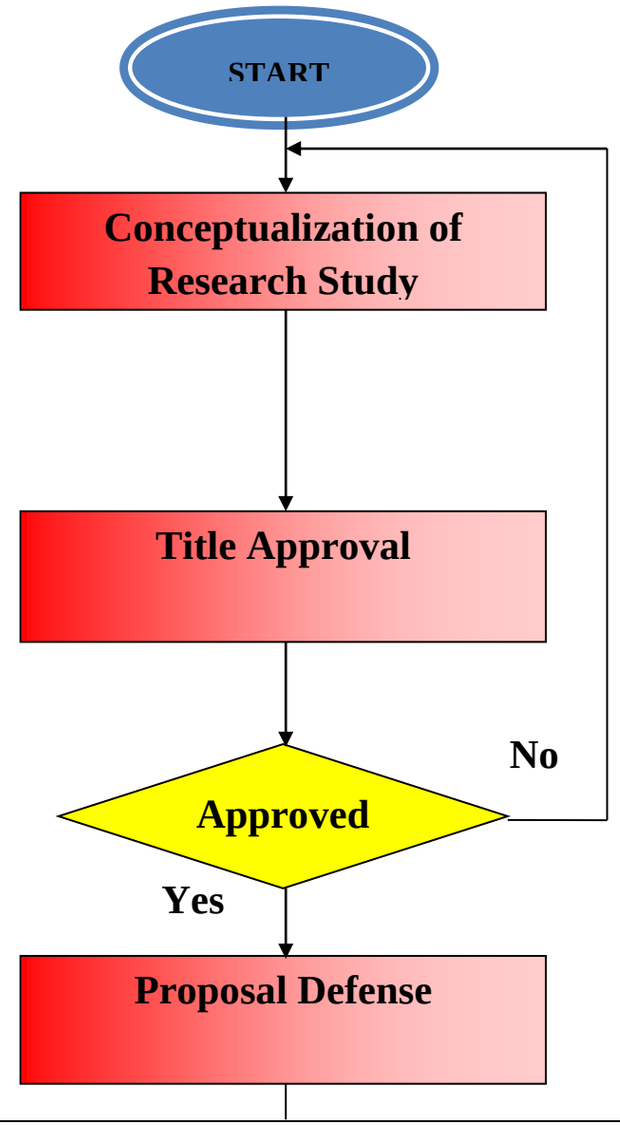
Roles/Responsibilities of the Research Professors

1. Prepares schedule for the Defense.
2. Prepares report after the Final Defense.
3. Act as a Mediator during the Defense.

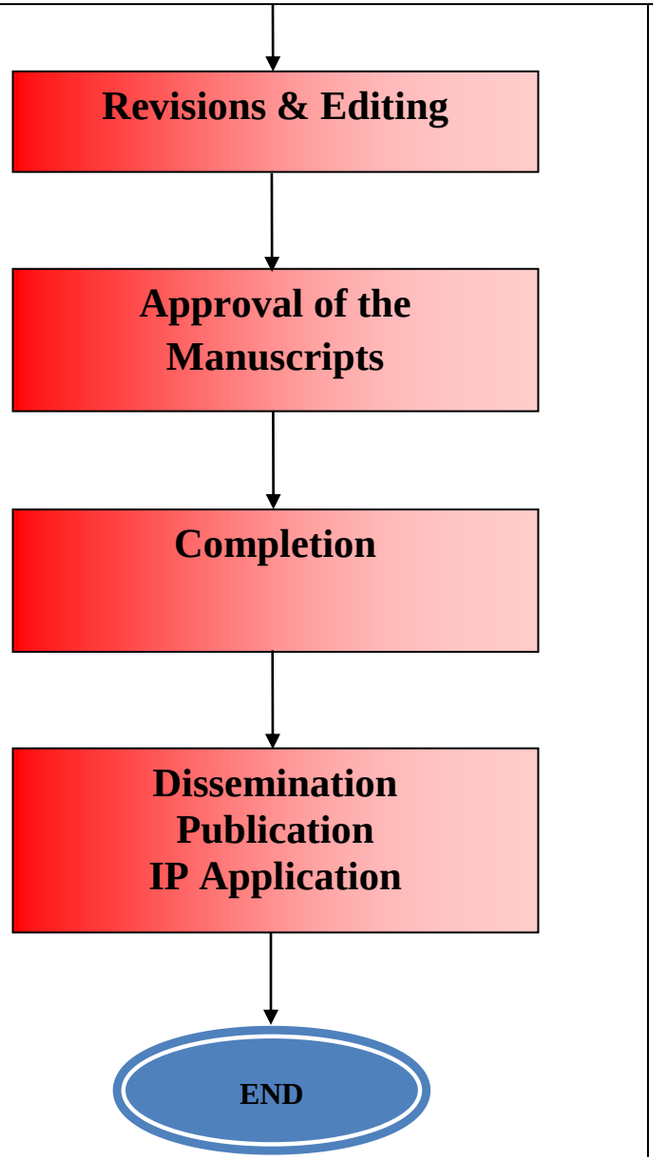
Appendix D

WORK INSTRUCTION

APPROVAL AND IMPLEMENTATION OF STUDENT RESEARCHES

Process Flow	Responsible Person	Details
	- Student Researcher/s - Research Professor	1. The student researcher/s will formulate feasible study with supervision of the research professor. Request for thesis/ technical/content adviser also shall be done.
	- Research Professor - Thesis Adviser - Dept. Chairman - Research Coordinator - Dean	2. Responsible persons evaluate the title. If approved, the student researcher/s requests thesis evaluator/panelist and schedule for oral defense. If did not approve, student researcher/s formulates another feasible study/project.
	- Student Researcher/s - Thesis Adviser - Technical/Content Adviser - Thesis Evaluators	3. Researcher/s presents the research proposal to be evaluated by the responsible persons.

Revisions	- Student Researcher/s - Thesis Adviser	4. Researcher/s revised the thesis proposal based from the comments and suggestions stated by the evaluators during the proposal defense.
Approval of Research Proposal	- Thesis Adviser - Technical/Content Adviser - Thesis Evaluators - Dept. Chairman - Dean	5. Revised proposal shall be approved by the responsible persons to start the data gathering.
Data Gathering	- Student Researcher/s - Thesis Adviser - Technical/ Content Adviser	6. Student researcher/s gathers data through the use of different instruments and research methods.
Documentation of Research Results	- Student Researcher/s - Thesis Adviser	7. Collected data will be presented narrative/ graphical representation such as tables and graphs for convenient analysis of the made by the study. Afterwards, an oral defense shall be scheduled.
Final Defense	- Student Researcher/s - Thesis Adviser - Technical/Content Adviser - Technical Evaluators	8. Panelist conducts technical evaluation based from the results that had been established.

	- Student Researcher/s - Thesis Adviser - Thesis Adviser - Technical/ Content Adviser - Thesis Evaluators - Dept. Chairman - Dean - Student Researcher/s - Research Professor - Research Coordinator - Student Researcher/s - Research Coordinator - Intellectual Property Office	9. Research results and documentation will be revised based from the comments given by the evaluators. Then, the editor will fix the errors in grammars and spelling. 10. Responsible persons will approve the manuscripts before it will be submitted for bookbinding. 11. Student Researcher/s shall submit three (3) hard copies and one (1) electronic copy of their bounded thesis to the research professor and later submitted to the research coordinator. 12. Students should participate in fora/conferences as a form of research results dissemination. Likewise, it should be published in journals. Research outputs shall be applied for intellectual property.

Appendix E

Republic of the Philippines
Bicol University
POLANGUI CAMPUS
Computer Studies Department
Polangui, Albay

APPLICATION FOR WORKING TITLE

Name: (**Name 1)**
(**Name 2)**
(**Name 3)**

Yr. Level and Block: (**BSxx-xx)**

This is to request for the approval of our working title: (**Title goes here)** with our adviser (**Thesis adviser goes here**).

Reasons: We choose to conduct this research (**reasons here**).

(**Name 1)** (**Name 2)** (**Name 3)**
Name & Signature of Students

Conforme:

MARIA CHARMY A. ARISPE, DIT
Research Professor

(**Name of Adviser)**
Capstone/Thesis Adviser

Recommending Approval:

ARNOLD B. PLATON, MSCS
Department Chair

FLORADEL S. RELUCIO, MIT
Research Coordinator

Approved:

MARY JOY B. CATANGUI, Ed.D.
Dean

Republic of the Philippines
Bicol University
POLANGUI CAMPUS
Computer Studies Department
Polangui, Albay

APPOINTMENT OF THESIS ADVISER

February 02, 2020

FLORADEL S. RELUCIO, DIT
Faculty
Bicol University Polangui Campus
Polangui, Albay

Dear **Dr. Relucio**:

Upon recommendation of the Research Professor, may we invite you to act as Thesis Adviser of **Mr. Jeffrey Roslin**, **Mr. Nelson P. Tibor Jr.**, **Mr. Salvador Alpapara Jr**., and **Mr. Jeffrey Baria** who work on the topic "**Sensored Emergency Light – Powered by Solar Energy**", which is scheduled for its Proposal Defense on February 15, 2011, at the Computer and Engineering Studies Department Office.

As adviser, you shall perform the following tasks:

1. Check the format of the manuscript;
2. Provide general editing of the thesis work;
3. Check the content and organization of the paper;
4. Attend the defense sessions of the advisee(s) and record suggestions and recommendations of the panel.
5. Provide ample time to the advisee(s) in relation to the experimental work during the conduct of the study, and
6. Orient the advisee(s) on what might /will transpire during the defense session.

Thank you and once again, we acknowledge the magnanimous support you have extended to our students in the development of their research capabilities.

Very truly yours,

MARY JOY B. CATANGUI, Ed.D.
Dean

Conforme:

FLORADEL S. RELUCIO, DIT
Capstone Project Adviser

Republic of the Philippines
Bicol University
POLANGUI CAMPUS
Computer Studies Department
Polangui, Albay

APPOINTMENT OF THESIS EVALUATORS

March 29, 2020

MARY ANTONIETTE S. ARIŇO
JOSEPH L. CARINAN
JERRY B. AGSUNOD, MIT

You are hereby appointed to constitute the Thesis Panel as indicated above to evaluate the research work of **Zandro R. Belardo, Sunshine C. Reodique** and **Richard D. Se** who work on the topic **"Computer Aided Instruction in Technical Drafting on Technology Courses."**

As such you are tasked to:

1. Appraise the validity and acceptability of the thesis work in terms of its scholarly quality, correctness of the facts and claims contained therein; and completeness as to its basic components,
2. Make sure that all suggestions are judiciously incorporated,
3. Evaluate the research report based on the adopted criteria, and
4. Be physically present during the oral defense.

You shall be entitled to an honorarium as chairman and as member.

MARY JOY B. CATANGUI, Ed.D.
Dean

CONFORME:

MARY ANTONIETTE S. ARIÑO
Panel Chairman

JOSEPH L. CARINAN
Member of the Panel of Evaluators

JERRY B. AGSUNOD, MIT
Member of the Panel of Evaluators

Republic of the Philippines
Bicol University
POLANGUI CAMPUS
Computer Studies Department
Polangui, Albay

RECOMMENDATION FOR PROPOSAL DEFENSE

This undergraduate capstone project entitled, "**Computer Aided Instruction in Technical Drafting on Technology Course**", prepared and submitted by **Zandro R. Belardo, Sunshine C. Reodique** and **Richard Se** in partial fulfillment of the requirements for the degree of **Bachelor of Science in Information Technology** submitted to the thesis committee for their consideration and approval to conduct the study.

FLORADEL S. RELUCIO, DIT
Capstone Project Adviser

Republic of the Philippines
Bicol University
POLANGUI CAMPUS
Computer Studies Department
Polangui, Albay

APPLICATION FOR FINAL DEFENSE

March 10, 2020

ARNOLD B. PLATON
Department Chair

Sir:

We are a candidate for the degree in Bachelor of Science in Information Technology. In this regard, may we would like to inform your office that we ready for the Oral Defense of our capstone project entitled:

WEB-BASED INTERNET USER MANAGER SYSTEM
(Proposed Study)

on _____ _____ _____
(Day) (Date) (Time)

Anticipating for your favorable action on this request.

SHARMAENE A. BORRES **FRANCESE A. BORRA** **MAENE A. SAYCO**

ENDORSEMENT OF THE ADVISER

This certifies that I have examined the thesis/research project manuscript of this candidate/examinee. Having served as the main critic for the same, I am now endorsing this manuscript for oral defense before the Oral Defense Panel.

FLORADEL S. RELUCIO, DIT
Adviser

Conforme:

PANELIST	Printed Name	Signature	Date
1. Panel Chairman	_____	_____	_____
2. Panel Member	_____	_____	_____
3. Panel Member	_____	_____	_____
4. Adviser	_____	_____	_____
5. Course Coordinator	_____	_____	_____
6. Department Chairman	_____	_____	_____

Recommending Approval:

MARIA CHARMY A. ARISPE, DIT
Research Professor

Noted by:

MARY ANTONIETTE S. ARIŇO
BSIS Course Coordinator

Approved:

ARNOLD B. PLATON, MSCS
Department Chair

Republic of the Philippines
Bicol University
POLANGUI CAMPUS
Computer Studies Department
Polangui, Albay

RECOMMENDATION FOR FINAL DEFENSE

This undergraduate capstone project entitled, "**Computer Aided Instruction in Technical Drafting on Technology Course**", prepared and submitted by **Zandro R. Belardo, Sunshine C. Reodique** and **Richard Se** in partial fulfillment of the requirements for the degree of **Bachelor of Science in Information Technology** submitted to the thesis committee for their consideration and approval to conduct the study.

FLORADEL S. RELUCIO, DIT
Capstone Project Adviser

Republic of the Philippines
Bicol University
POLANGUI CAMPUS
Computer Studies Department
Polangui, Albay

CERTIFICATION OF FINAL RATING

Capstone Title: IT+ Organization Web-based Payment Monitoring System

Venue : Virtual via Google Meet

Date : October 11, 2021

Researchers : CONJE, RYMAR L.

IMPERIAL, MAICA DC.

SALAMATIN, SHERYL G.

Panel of Examiners	**Action Taken**	**Signature**
JERRY B. AGSUNOD, MIT Chairperson	_____	_____
FLORADEL S. RELUCIO, DIT Member	_____	_____
VINCE ANGELO E. NAZ, MIT Member	_____	_____

Republic of the Philippines
Bicol University
POLANGUI CAMPUS
Computer Studies Department
Polangui, Albay

APPROVAL SHEET

This undergraduate thesis entitled, "**Android-Based Orchid Classification using Convolutional Neural Network**" prepared and submitted by **Babylyn M. Boado, Katrina L. Ludovice** and **Catherine A. Rebancos**, in partial fulfillment of the requirements for the degree of Bachelor of Science in Computer Science (BSCS) has been examined and recommended for acceptance and approval.

JERRY B. AGSUNOD, MIT
Thesis Adviser

BEN L. SAMINIANO, MET
Chairman

MARIA CHARMY A. ARISPE, DIT
Member

JOSEPH L. CARINAN
Member

Accepted and approved in partial fulfillment of the requirements for the Bachelor of Science in Information Technology.

ARNOLD B. PLATON, MSCS
Department Chair

MARY JOY B. CATANGUI, Ed.D.
Dean

Republic of the Philippines
Bicol University
POLANGUI CAMPUS
Computer Studies Department
Polangui, Albay

February 1, 2022

To: **JERRY B. AGSUNOD, MIT** - Thesis Adviser

BEN L. SAMINIANO, MET - Panel Chairman

MARIA CHARMY A. ARISPE, DIT - Panel Member

JOSEPH L. CARINAN - Panel Member

You are hereby advised to sit as adviser, chairman and members of the Thesis Committee for the thesis defense entitled "**Android-Based Orchid Classification using Convolutional Neural Network**" of **Babylyn M. Boado, Katrina L. Ludovice** and **Catherine A. Rebancos** which will be schedule on _____ via Google meet platform.

MARY JOY B. CATANGUI, Ed.D.
Dean

Republic of the Philippines
Bicol University
POLANGUI CAMPUS
Computer Studies Department
Polangui, Albay

CERTIFICATION OF EDITOR

This undergraduate capstone project entitled, **"IT+ Organization Web-based Payment Monitoring System"**, prepared and submitted by **Rymar L. Conje, Maica DC. Imperial,** and **Sheryl G. Salamatin** in partial fulfillment of the requirements for the degree of **Bachelor of Science in Information Technology (BSIT)** has been read and edited by the undersigned.

Signed this 5th day of January, 2022 at Libon Agro-Industrial High School, Libon, Albay.

Name of Editor
Editor