## OUTCOMES-BASED EDUCATION

Business Intelligence and Data Warehouse Case

In 2012, the Commission on Higher Education advised all higher education institutions in the Philippine to shift to a new educational system called Outcomes-Based Education (or OBE). It is a paradigm of education that shifts from the traditional content-based education (education is focused on the delivery and coverage of content) to an educational system focusing on building capabilities demanded by the workplace to which the degree is preparing the students for. It is a system built on a **structured hierarchy of capabilities and their component competencies** that guides how courses will be designed and delivered. Another aspect of OBE is the emphasis on measuring the level of achievement of students on these declared capabilities (instead of traditional systems that focuses on measurement of mastery of knowledge). These measurements are used to analyze what is happening in the educational system (in the perspective of outcomes achievement) and the results of such analysis is used to introduce improvements within the educational system. Institutions that started to implement OBE are faced with a scenario of collection measurement data and process them manually using office productivity tools like Microsoft Excel. Analysis is a cognitive process of dividing a situation into its dimensions for purposes like understanding, determining problems, identifying strengths and weaknesses, among others. Analysis of outcomes achievement results involves the same cognitive process and could be improved if provided with a technological tool to allow decision-makers to do this dimensional-based process.

### Structured hierarchy of capabilities and component competencies

In an institution, a set of Institutional Graduate Attributes (or IGA) is declared based on its Mission and Vision. Graduate Attributes are characteristics of an individual that identifies him/her to be a product of the institution. In each attribute, a set of Institutional Graduate Outcomes are articulated that communicates what exactly a person with that attribute is capable of doing. This is called the Institutional Graduate Outcomes (IGO). Table 1.0 shows an example of IGA and its corresponding IGO.

| IGA Code | IGA | IGO Code | Graduate Outcome |
|---|---|---|---|
| CCT | Critical and Creative Thinker | **I01** | Generates ideas, designs, systems or information with resourcefulness, imagination, insight, originality, aesthetic judgment, enterprise and a risk-taking approach to meet current and emerging needs |
| | | **I02** | Uses innovative methods and technologies to solve problems and making decisions |
| EC | Effective Communicator | **I03** | Communicates effectively and confidently to different audiences |
| | | **I04** | Listens actively to the intent and spirit of others' words and respond appropriately verbally and non-verbally |
| | | **I05** | Composes and comprehends a range of written, spoken and visual text to convey information |
| | | **I06** | Explores ideas critically and expresses findings clearly for a variety of purposes |
| RLL | Reflective Lifelong Learner | **I07** | Critically reflects on problems and issues to shape ideas and solutions that contribute to a better understanding |
| | | **I08** | Critically evaluates and reflects on their assumptions and values |
| | | **I09** | Plans, organizes, manages and evaluates own thinking, performance, behavioral and well being |
| SDC | Service-Driven Citizen | **I10** | Creates products and performances that achieve their purpose and are appropriate for their intended audience |
| | | **I11** | Develops and contributes positively to the accomplishment of team goals through collaborative processes |
| | | **I12** | Develops and practices effective interpersonal skills in order to relate to others |
| | | **I13** | Evaluates their values and sense of responsibility through participation in a range of learning contexts |

**Table 1.0 ELGA and its corresponding IGO (sample)**

IGOs are target capabilities by General Education courses. Each general education course should be targeting an IGO it will develop through the course. IGOs that each of the general education courses needs to target is articulated in a document called General Education Curriculum Map (GECM). Table 2.0 shows a sample of this curriculum map. In the sample provided, ITMATH1 was assigned to develop I02 and I03. This means that at the end of the course, these capabilities must be developed. The curriculum map serves as a guide in how syllabus will be designed. This will be discussed in later sections of this document.

| Course | Units | I01 | I02 | I03 | I04 | I05 | I06 | I07 | I08 | I09 | I10 | I11 | I12 | I13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SCIENVB | 2.0 | | X | | | | X | | | | | | | |
| ITMATH1 | 3.0 | | X | X | | | | | | | | | | |
| FILKOMU | 3.0 | | | | | X | | X | | | X | | | |
| FITWELL | 3.0 | | | | | | | | X | X | | | | X |

**Table 2.0 Sample General Education Curriculum Map (GECM) (Sample)**

## DEGREE PROGRAMS

Each degree program offered in an institution has its own set of Program Graduate Attributes (or PGA). Each PGA is a specific version of the IGO for the degree program. Table 3.0 shows a sample of Program Graduate Attributes for BS Computer Science and the Institutional Graduate Attribute it is part of.

| Institutional Graduate Attribute | BS Computer Science Program Graduate Attributes |
|---|---|
| Critical and Creative Thinker | Knowledge for Solving Computing Problems |
| | Problem Analysis |
| | Design/Development of Solutions |
| | Modern Tool Usage |
| Effective Communicator | Communication |
| Service-Driven Citizen | Individual and Team Work |
| | Computing Professionalism and Ethics |
| Reflective Lifelong Learner | Life-long Learning |

**Table 3.0 Sample Program Graduate Attribute for BS Computer Science**

Just like IGA, each Program Graduate Attribute has its set of Program Intended Learning Outcomes (or PILO) that articulates the set of capabilities expected of graduates of the degree program. Table 4.0 shows a sample of Program Intended Learning for each PGA of the BS Computer Science Program.

| Institutional Graduate Attribute | BS Computer Science Program Graduate Attributes (PGA) | PILO Code | BS Computer Science Program Intended Learning Outcomes (PILO) |
|---|---|---|---|
| Critical and Creative Thinker | Knowledge for Solving Computing Problems | **CS01** | Abstract and conceptualize computing models from defined problems and requirements, applying knowledge of computing fundamentals, knowledge of a computing specialization, and mathematics, science, and domain knowledge appropriate for the computing specialization |
| | 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** | Model and design computer-based systems in a way that demonstrates comprehension of the tradeoffs involved in design choices, using knowledge in mathematics, algorithmic principles and computer science theories |
| | | **CS04** | Design and evaluate possible solutions for complex computing problems, and design and evaluate software systems of varying levels of complexities, components, or computing processes that meet specified user and domain needs taking into tradeoffs involved in design choices with appropriate consideration for public health and safety, cultural, societal, and environmental considerations |
| | Modern Tool Usage | **CS05** | 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 |
| Effective Communicator | Communication | **CS06** | 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 |
| Service-Driven Citizen | Individual & Team Work | **CS07** | Function effectively as an individual and as a member or leader in diverse teams and in multidisciplinary settings |
| | Computing Professionalism and Ethics | **CS08** | Adopt appropriate professional, ethical and legal practices as a result of recognizing the legal, social, ethical and professional issues involved in the utilization of computer technology |
| Reflective Life Long Learner | Life-Long Learning | **CS09** | Engage in independent learning for continual development as a result of recognizing the need to develop further as a computing professional |

**Table 4.0 Sample Program Intended Learning Outcomes for BS Computer Science**

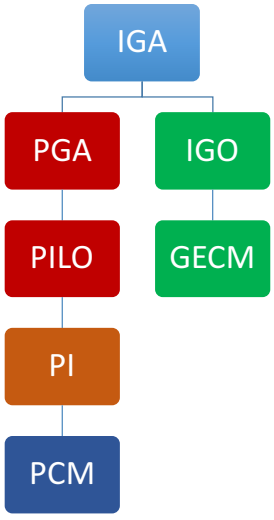


Figure 1.0 Structured hierarchy of capabilities and component competencies

Before we continue further discussing the other remaining parts of the Structured hierarchy of capabilities and component competencies that are defined when implementing OBE, let's review them and summarize the terminologies. Figure 1.0 shows the hierarchy so far as discussed above. The institution articulates a set of Institutional Graduate Attributes (IGA) to communicate the characteristics of its graduates (regardless of any degree) based on the institution's mission and vision. Each IGA is divided into Institutional Graduate Outcomes (IGO) to communicate the specific capability of a person with such characteristics. These IGOs are assigned to the General Education Courses, and the assignment is articulated in the General Education Curriculum Map (GECM). On the part of the degree programs, each degree program makes a set of Program Graduate Attributes to communicate how the IGA becomes specific to the degree. A PILO (or a set of PILO) is articulated for each PGA representing the capability of a graduate of the degree with such an attribute.

A PILO is a capability expected to be developed at the end of the Degree program. Since PILO are big capabilities that cannot be handled by a course, it needs to be divided further to component capabilities called Performance Indicators (PI). Performance indicators are still capabilities that courses can promise and be assigned to developed. They can be achieved even at the middle of the curriculum (typically towards the 3rd and 4th year) and not necessarily at the end of the program. A sample of what Performance Indicators are, is shown in table 5.0.

Just like IGO being assigned to General Education courses, Performance Indicators are assigned to Professional courses, and the assignment is articulated in the Professional Curriculum Map (PCM). Table 6.0 provides a sample of this curriculum map.

| Institutional Graduate Attribute | BS Computer Science Program Graduate Attributes (PGA) | PILO Code | BS Computer Science Program Intended Learning Outcomes (PILO) | Performance Indicators (PI) |
|---|---|---|---|---|
| Critical and Creative Thinker | Knowledge for Solving Computing Problems | **CS01** | Abstract and conceptualize computing models from defined problems and requirements, applying knowledge of computing fundamentals, knowledge of a computing specialization, and mathematics, science, and domain knowledge appropriate for the computing specialization | CS01.1. Defend computer-based models and solution ideas using knowledge of mathematics, computing fundamentals and technical concepts and domain knowledge<br>CS01.2. Conceptualize solution models in different levels of abstraction and solution frameworks by applying knowledge of computing fundamentals, technical concepts and practices, best practices and standards in the application of core information technologies, mathematics, science, and domain knowledge appropriate for the information technology |
| | 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 | CS02.1. Identify user needs and requirements based on a comprehensive gathering of data and information<br>CS02.2. Formulate literature necessary for the understanding of requirements and solutions<br>CS02.3. Research on related literature that will guide the gathering of data and the development of solutions to complex Information Technology problems<br>CS02.4. Analyze user needs and requirements to determine specific areas where computing solutions will be used<br>CS02.5. Reach substantiated conclusions and recommendations using fundamental principles of mathematics, computing fundamentals, technical concepts and practices in the core information technologies, and relevant domain disciplines. |
| | Design/Development of Solutions | **CS03** | Model and design computer-based systems in a way that demonstrates comprehension of the tradeoffs involved in design choices, using knowledge in mathematics, algorithmic principles and computer science theories | CS03.1. Formulate set of alternative solutions to address complex computing problems<br>CS03.2. Develop specifications to facilitate development and implementation of solutions |
| | | **CS04** | Design and evaluate possible solutions for complex computing problems, and design and evaluate software systems of varying levels of complexities, components, or computing processes that meet specified user and domain needs taking into tradeoffs involved in design choices with appropriate consideration for public health and safety, cultural, societal, and environmental considerations | CS04.1. Design systems, components, or processes with resourcefulness, imagination, insight, originality, aesthetic judgment, enterprise and risk taking approach to meet specified user needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations<br>CS04.2. Develop and implement solutions from given specifications<br>CS04.3. Formulate test cases that represents real world scenarios that will assess the fitness to purpose and level of satisfaction of user needs of the designed and developed systems, components or processes<br>CS04.4. Conduct testing to determine the level of compliance of developed systems, components or processes to desired results<br>CS04.5. Assess and evaluate designs and implementations of systems, components or process for its feasibility, effectiveness, achievement of quality requirements and standards<br>CS04.6. Recommend and introduce corrections (debug), improvements and modifications to existing solutions (systems, components or processes) to improve its appropriateness and effectiveness in addressing problems and/or requirements. |
| | Modern Tool Usage | **CS05** | 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 | CS05.1. Evaluate techniques, methodologies, standards/frameworks, methods and tools for its appropriateness to the complex computing activities to be performed considering its advantages and limitations<br>CS05.2. Select, use and adapt appropriate techniques, methodologies, standards/frameworks, methods and tools to complex computing activities<br>CS05.3. Create new tools as necessary to improve the efficiency and effectiveness of performing tasks and achieve goals |
| Effective Communicator | Communication | **CS06** | 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 | CS06.1. Interview clients to gather background information, situation, existing concerns and issues necessary to frame and achieve common understanding of problems to be addressed by computing solutions<br>CS06.2. Write effective reports and documentations about the results of performing specific computing and professional tasks completely and comprehensively, with appropriate tone, correct grammar and construction, adapting to documentation standards, to communicate ideas, choices, assumptions, and consequences of decisions<br>CS06.3. Develop effective presentation material that will enhance understanding of ideas being communicated<br>CS06.4. Deliver presentations effectively and efficiently to various audience (computing community, society at large, and users) using English and Filipino as needed, with appropriate tone, correct grammar and construction |

| Institutional Graduate Attribute | BS Computer Science Program Graduate Attributes (PGA) | PILO Code | BS Computer Science Program Intended Learning Outcomes (PILO) | Performance Indicators (PI) |
|---|---|---|---|---|
| Service-Driven Citizen | Individual & Team Work | **CS07** | Function effectively as an individual and as a member or leader in diverse teams and in multidisciplinary settings | CS07.1. Perform tasks independently without the need for prodding<br>CS07.2. Coordinate with other business professionals and professionals from other disciplines to achieve goals and complete tasks<br>CS07.3. Set proper goals and timeline of activities to complete team objectives<br>CS07.4. Manage tasks and resources according to team member capabilities and group objectives<br>CS07.5. Resolve and reduce conflicts and issues within the team |
| | Computing Professionalism and Ethics | **CS08** | Adopt appropriate professional, ethical and legal practices as a result of recognizing the legal, social, ethical and professional issues involved in the utilization of computer technology | CS08.1. Assess societal, health, safety, legal and cultural issues within organizational, national and/or global contexts as needed in the domain where computing solutions will be conceptualized, designed and implemented<br>CS08.2. Make design and implementation decisions considering the societal, health, safety, legal and cultural issues involved and the impact to these to such decisions<br>CS08.3. Act upon the consequential social, legal and professional responsibilities |
| Reflective Life Long Learner | Life-Long Learning | **CS09** | Engage in independent learning for continual development as a result of recognizing the need to develop further as a computing professional | CS09.1. Consistently conform to the professional code of ethics, and professional norms governing the performance of computing activities<br>CS09.2. Perform responsibilities and accept accountability of the consequences of not performing responsibilities as expected<br>CS09.3. Reflect on own abilities and skills to determine necessary development needs to reach level of expectations and aspirations as a computing professional<br>CS09.4. Prepare a personal development plan<br>CS09.5. Engage independently in developmental activities (like participating in professional organizations, attendance to seminars and training) as a result of recognizing the need to further and continuously develop one's competencies as a computing professional<br>CS09.6. Evaluate achievements and deficiencies against owns personal development plan |

**Table 5.0 Sample Performance Indicators for each PILO of the BS Computer Science Program**

| Course | Units | CS01.1 | CS01.2 | CS02.1 | CS02.2 | CS02.3 | CS02.4 | CS02.5 | CS03.1 | CS03.2 | CS04.1 | CS04.2 | CS04.3 | CS04.4 | CS04.5 | CS04.6 | CS05.1 | CS05.2 | CS05.3 | ..... | CS09.5 | CS09.6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LOGPROG | 3.0 | | | | | | | | | | | X | | X | | | | | | | | |
| INTR-IT | 3.0 | X | | | | X | | | | | | | | | | | | | | | | |
| INTPRG1 | 3.0 | | | | | | | | | | | X | | X | | | | | | | | |
| ITORGMNT | 3.0 | X | X | | | | | | | | | | | | | | | | | | | |

**Table 6.0 Sample Program Curriculum Map (PCM) (Sample)**

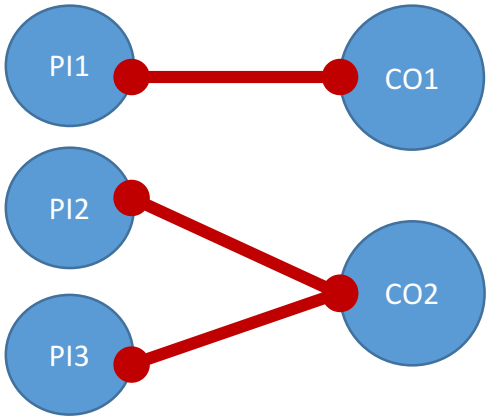


**Figure 2.0 Relationship of Performance Indicators to Course Outcomes**

Because of the curriculum map, courses are assigned performance indicators to develop. When the course syllabus is developed, these indicators serve as a guide for the identification of course outcomes. Course outcomes are the target capabilities expected to be developed at the end of the course. This should be aligned to the performance indicators assigned to the course. In an OBEdized course, figure 2.0 shows the relationship of the PI to Course Outcomes.

A. One course outcome can represent one performance indicator assigned to the course.
B. One course outcome can represent two or more performance indicators assigned to the course.

A sample of how course outcomes are developed aligned to performance indicators and the two possible relationships of PI to Course Outcomes is shown in table 7.0

This relationship is very important since in an OBEdized course, course outcomes are given a grade and the grade for each performance indicator assigned to the course is usually derived. In the case of relationship type A, the grade of CO1 becomes the grade for PI1 assigned to the course. In the case of relationship type B, the grade of CO1 cannot automatically be the grade for PI2 and PI3. What happens is that the teacher should provide a grade for each of the PI that the course outcome represents (see figure 3.0)

| Original Performance Indicators assigned to the Course | | Course Outcomes |
|---|---|---|
| CS04.1 Design systems, components, or processes with resourcefulness, imagination, insight, originality, aesthetic judgment, enterprise and risk taking approach to meet specified user needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations | **CO1** | Design a program based on specified specifications |
| CS04.2 Develop and implement solutions from given specifications | **CO2** | Develop and implement a program based on specified specifications using 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, and applying procedural abstraction |
| CS04.4 Conduct testing to determine the level of compliance of developed systems, components or processes to desired results<br>CS04.5 Assess and evaluate designs and implementations of systems, components or process for its feasibility, effectiveness, achievement of quality requirements and standards | **CO3** | Conduct testing to determine the compliance of the program to specifications and assess its effectiveness in achieving desired results |
| CS04.6 Recommend and introduce corrections (debug), improvements and modifications to existing solutions (systems, components or processes) to improve its appropriateness and effectiveness in addressing problems and/or requirements. | **CO4** | Debug a program to improve its effectiveness in addressing specifications |

**Table 7.0 Sample Course Outcome alignment and relationship to Performance Indicators assigned to the course**

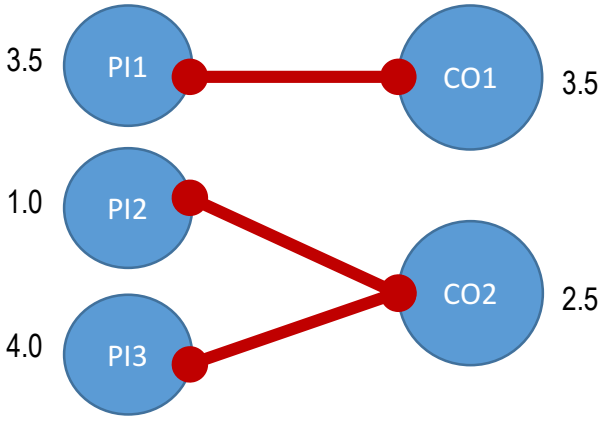


**Figure 3.0 How grades are determined for course outcomes and performance indicators**

Aside from these grades, each course still has a final grade.