International Journal of Digital Information and Wireless Communications (IJDIWC) 3(4): 350-362
The Society of Digital Information and Wireless Communications, 2013 (ISSN: 2225-658X)

# Constructing a Course Profile by Measuring Course Objectives

Neville I. Williams
School of Computer Science, Engineering and Mathematics
Flinders University,
GPO Box 2100, Adelaide 5001, Australia
Neville.Williams@flinders.edu.au

## ABSTRACT

An ongoing goal in higher education is to provide quality education programs and to produce high quality graduates. While much of the attention to quality matters is focussed on outputs, there is little that addresses the preliminary or input side of the educational program. The purpose of this paper is to demonstrate that it is feasible to construct a course profile based on standard inputs in the form of the behavioral objectives that are stated for the subjects comprising the course. The application of the course profile will be found in supplementing the understanding of quality frameworks in the assessment of degree programs, thereby becoming a useful tool for benchmarking courses and comparing across department and institution boundaries.

## KEYWORDS

course profile, benchmarking, course evaluation, course quality

## 1. INTRODUCTION

In the higher education sector a continuing issue remains at the forefront of the teaching and learning agenda, and that is quality of the degree programs offered. There are many initiatives undertaken to investigate the quality of teaching, the quality of assessment, the quality of graduates, and other output evaluations. These are all post-event or post-process activities that have an important role in attempting to validate and maintain institutional quality standards. Applications of this approach are particularly evident at times of course accreditations or during benchmarking processes when various forms of documentation are provided as evidence of effective quality teaching, learning and assessment processes being in place.

When these evaluation and audit processes occur, a significant element that is examined is the documentation associated with a complete program (a degree, or a course) and its component elements (the individual subjects, or topics, or courses). In particular, the aims and objectives are reviewed, and then the outputs and deliverables associated with the member items are examined and evaluated. The bracketed terms are listed to show the variability in terminology usage across the education sector where for example the term *course* may mean either a whole degree program in one institution or a semester (subject) of study in another.

The purpose of this paper is to focus on the initial part of this documentation, namely the aims and objectives of individual component elements, and to propose that a profile can be established for each of the subjects in a degree program, and by extension therefore to arrive at an overall course profile that may be used as an indicator of course intent. When implemented, this profile can be used to provide key stakeholders with a predictive capacity that presently does not exist. For example, students could compare courses in a quantitative manner to supplement their qualitative decision making on course selection. University administrations could compare courses within their institution to confirm consistency or identify inconsistency between department offerings. External course reviewers and evaluators could establish baseline expectations for the conduct of their reviews and audits. Being an input-side or pre-process activity, there is an inherent value in such a profile being created.

While at first appearing to be either confronting, or perhaps an impossible dream, it should be pointed out that many other areas of endeavor have metrics that are used to provide initial expectations for evaluators on which to base their judgements. Simple examples include the ‘degree of difficulty’ factor used in judging some Olympic events such as diving, gymnastics, dance and similar. In the health sector in Australia the case-mix approach identifies a ‘standard’ time in hospital for various medical procedures, and in financial accounting there exists the 'standard cost' for production of component items in manufacturing processes. Why then should it not be possible to establish a baseline value that may be used as an indicator to the educational potential of course-work studies? As will be shown in the remainder of this paper, a proposed course profile indicator is feasible.

## 2. THE HIGHER EDUCATION SECTOR

For the purposes of this paper, the focus will be constrained to the degree programs of the higher education sector.

Structurally, a degree program comprises a number of specified studies that must be undertaken in an acceptable combination to satisfy the requirements of the particular degree. Typically the studies are organized on a semester basis, and, depending on the institution concerned, the studies may have the same weighting value in each semester, or there may be differences. For each subject, there is a set of aims and objectives that are intended to provide information about the content of the subject and the skills and knowledge that a student should attain. To clarify the use of terms in this paper, a brief set of interpretation definitions and equivalences is given in Table 1 below:

### 2.1 Relationship between Elements

The higher education enterprise may be viewed as a composite set of the elements just discussed and arranged in an hierarchical order as shown in Table 2.

At the subject level, the subject specification may be thought of as the set of the learning objectives for that subject. Typically these are expressed in behavioral terms and are therefore usually prefaced with a statement such as "On successful completion of this subject the student will be able to …".

In practice, each degree/course has its own course aims and objectives, which are presumably addressed by one or more of the individual subject learning objectives. These overarching aims and objectives are intended to convey a sense of the overall graduate attributes that should be realized in the successful students, and provide some thematic relevance or intent across the subjects in the course.

University standards require that each subject has an approved assessment and examination scheme, and a fundamental principle of university teaching is that the assessment plan tests the achievement of the subject learning objectives. On the assumption that this principle is valid and applied in every case, it is reasonable to assume that any student who has received a passing grade has met the subject specifications. Of course the reality is that the assessment of students is not quite so simplistic otherwise there would exist just Pass and Fail as the two possible outcomes for students. What students, educators, and potential employers wish to see is a qualifier on the level of pass attained, so we have grading systems that extend beyond the simple Pass/Fail criteria and include additional classifications such as Credit, Distinction, and High Distinction. Some systems allocate grades in the range A to E, or A to F, with similar interpretations being applied to the final grade. Rather than being purely indicators of success, these categories generally show some form of performance index, and may include other factors such as the way in which students have applied themselves to the subject at hand. Typically those students who engage well with the subject will achieve higher grades than those students who minimize their efforts to satisfy the subject requirements. The relative performance of students is used by universities world-wide and accumulated into a statistic known as GPA (Grade Point Average). This statistic is then used for subsequent admissions to other courses or for the award of scholarships.

The question now becomes this:

**Is it feasible to construct a meaningful a-priori profile of a degree course based on subject learning objectives?**

## 3. DETERMINATION OF AN INDIVIDUAL SUBJECT PROFILE

In order to achieve a satisfactory course profile, it is necessary to examine the individual subjects that make up the course, and then aggregate the individual subject assessments to create an overall view.

**Table 1: Terminology Interpretations**

| Term | Meaning | Alternative Terminology |
|---|---|---|
| **Course** | A complete degree program | Degree, award |
| **Course Rule** | Specification for the combination of subjects to be completed in order to satisfactorily complete the course | Degree Regulations, Schedule of Study |
| **Subject** | A prescribed study program in a specific discipline area, typically over one semester | Topic, Course |
| **Unit Value** | The effective weight of the subject in the student load, typically expressed as a fraction of a full-time year | Course credits, Credit Points, Units |
| **Learning Objective** | A student learning objective written in behavioral terms | Learning Outcome |

**Table 2: Degree Hierarchy Structure**

| | | | |
|---|---|---|---|
| Degree Programs | Specific Course 1 | Subject 1 | Learning Objective 1 |
| | | | Learning Objective 2 |
| | | | …. |
| | | | Learning Objective $m_1$ |
| | | Subject 2 | |
| | | …. | |
| | | Subject $n_1$ | |
| | Specific Course 2 | Subject 1 | Learning Objective 1 |
| | | | Learning Objective 2 |
| | | | …. |
| | | | Learning Objective $m_2$ |
| | | Subject 2 | |
| | | …. | |
| | | Subject $n_2$ | |
| | …. | | |

Fortunately there have been several studies undertaken in the field of learning objectives, and two in particular deal with the development of taxonomies for learning objectives in an attempt to provide qualitative approaches to the examination of learning objectives. One of the key platforms that gained a great deal of support was the taxonomy of educational objectives proposed by Bloom, which subsequently became widely referred to as "Bloom's Taxonomy". The underlying basis of Bloom's ideas was to create a framework for classifying the statements of what was expected for students to learn through the teaching process. While the original publication of Bloom's work dates back to the 1950s, the evolutionary work resulting from the investigation and adoption of Bloom's approach has resulted in a more recent version now labelled as the "revised Bloom's Taxonomy" [1]. In essence, the revised taxonomy has expanded the Knowledge dimension of the original taxonomy and has become represented as a two-dimensional matrix mapping the Knowledge dimension against the Cognitive dimension, as shown in Table 3 [2]. Use of this tabular form allowed the analysis of the objectives of a unit or course of study, and in particular, enabled an indication of the extent to which more complex types of knowledge and cognitive processes were involved. It was found that this tabular form was able to be applied across a range of granularities, from the fine-grained analysis of a module in a larger teaching program, to broader analyses of subject objectives. The application of the revised Bloom Taxonomy matrix involves the examination of learning objectives and classifying them into the appropriate cells of the matrix.

In the accompanying table (Table 3), the terms in the cognitive dimension are self-explanatory, and similarly, the first three terms in the knowledge dimension are equally self-explanatory. However, the fourth term, "Metacognitive Knowledge" requires further explanation. In a related work, Pintrich [3] discusses the importance of metacognitive knowledge and highlights three distinct types. Specifically, Pintrich identifies the first type as "Strategic Knowledge", which incorporates the knowledge of strategies for learning, thinking and problem solving in the domain area. The second type is identified as "Knowledge about cognitive tasks", which includes the ability to discern more about the nature of the problems to be solved and to begin to know about the "what" and "how" of different strategies as well as "when" and "why" the strategies may be appropriate. The third type is described as "Self-Knowledge", which includes understanding about one's own strengths and weaknesses with respect to learning.

A second significant model is that proposed by Biggs in the form of the SOLO Taxonomy (Structure of Observed Learning Outcome), was not included as no teaching activity would be deliberately aimed at this ab-initio state.

While the initial intention of using the SOLO Taxonomy is to classify learning objectives into the appropriate SOLO categories, the work undertaken by Brabrand and Dahl enabled a relative measure of competencies to be established across the courses in the science faculties in the universities in the study. The body of evidence in the Brabrand and Dahl work has established a method to create a quantitative measure based on the statements of learning objectives.

which is described as a "means of classifying learning outcomes in terms of their complexity" and leading to the ability to "assess student work in terms of its quality …" [4]. Earlier publications from Biggs [5], which refers to an even earlier study by Collis and Biggs, outlines the 5 level structure of the SOLO Taxonomy and discusses the intent and interpretation of each of the 5 levels:

1. Pre-Structural
2. Uni-Structural
3. Multi-Structural
4. Relational
5. Extended Abstract

The application of the SOLO Taxonomy to the assessment of learning outcomes (objectives) involves the review of the objectives in terms of the functionality expected at the various levels. In particular, there are typical verbs associated with each level that are likely to appear in statements of learning objectives.

A study that attempted to provide a quantitative value conversion from the qualitative base of the taxonomy structure was conducted in Denmark where the data considered was over some 550 syllabi from the science faculties at two universities [6]. The approach in this study listed a number of typical verbs associated with the SOLO Taxonomy, and identified levels 2 and 3 as providing mostly quantitative outcomes and levels 4 and 5 as being more qualitative in nature, as shown in Table 4. The mapping of learning objective statement to a value was then given by the level number that the verb(s) in the objective most closely matched. SOLO Level 1

The method used by Brabrand and Dahl in the examination of syllabi was to count the frequencies of the verbs used in the learning objectives for the subjects and apply an average to the subject. It was further enhanced by using a 'double-weight averaging scheme', which meant that compound statements of learning objectives such as "identify … and compare …" would result in an averaging for that single objective of (S2 + S4)/2. In this approach, the values 2 to 5 were applied to the learning objectives based on their verb classification. The outcome of this method is to create a singular value for each subject syllabus objective within the range 2 to 5, and ultimately generate a single value for each

**Table 3: Revised Bloom Taxonomy Matrix**

| | Cognitive Dimension | | | | | |
|---|---|---|---|---|---|---|
| Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
| Factual knowledge | | | | | | |
| Conceptual knowledge | | | | | | |
| Procedural knowledge | | | | | | |
| Metacognitive knowledge | | | | | | |

**Table 4: Prototypical verbs according to the SOLO Taxonomy per Brabrand and Dahl**

| Quantitative | | Qualitative | |
|---|---|---|---|
| SOLO 2 Uni-structural | SOLO 3 Multi-structural | SOLO 4 Relational | SOLO 5 Extended Abstract |
| Paraphrase | Combine | Analyze | Theorize |
| Define | Classify | Compare | Generalize |
| Identify | Structure | Contrast | Hypothesize |
| Count | Describe | Integrate | Predict |
| Name | Enumerate | Relate | Judge |
| Recite | List | Explain causes | Reflect |
| Follow (simple) instructions | Do algorithm<br>Apply method | Apply Theory (to its domain) | Transfer Theory (to new domain) |

**Table 5: Revised Bloom Ranking Schedule**

| | Cognitive Dimension | | | | | |
|---|---|---|---|---|---|---|
| Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
| Factual knowledge | 1 | 5 | 9 | 13 | 17 | 21 |
| Conceptual knowledge | 2 | 6 | 10 | 14 | 18 | 22 |
| Procedural knowledge | 3 | 7 | 11 | 15 | 19 | 23 |
| Metacognitive knowledge | 4 | 8 | 12 | 16 | 20 | 24 |

subject. As described by the authors, there is an underlying assumption that the distance between each SOLO level is equal to enable the values 2 to 5 to be used in this manner. The term for this metric given by Brabrand and Dahl is “SOLO Average”.

The use of the SOLO classifications is quite simple at the conceptual level, and it also has an implied equality of learning competencies within each level. Hence, any learning activity that is classified at a particular SOLO level may be thought of as being educationally equivalent to every other learning activity at that level.

This is somewhat different from the revised Bloom Taxonomy which differentiates knowledge types within cognitive levels, but an interesting question arises to consider whether similar approaches can be used with the revised Bloom Taxonomy as a classification and metric determination tool. Under the equal distance assumption proposed in Brabrand and Dahl, the cognitive levels within any one knowledge dimension should change by an equal amount. Similarly, a constant distance value between knowledge dimension levels should apply within any one cognitive dimension. Accordingly, using an integral unit value a score value table could be constructed as in Table 5.

Given the revised Bloom Taxonomy matrix contains 24 cells, the resultant scale will be in the range 1 to 24. In pure numeric terms the scores obtained using this scale will be vastly different from those using the SOLO scale where the range is between 2 and 5. However it is worth examining whether meaningful outcomes are obtained using the two techniques. This approach has been taken on the grounds that behavioral objectives are written as statements of intended student behaviors and learning outcomes, which is about the cognitive skills rather than the subject content. Recognising that subject content should become more in-depth as a student progresses through their studies, it is reasonable to remove the depth of knowledge factor in determining a profile that examines the cognate skills.

As the knowledge dimension addresses the nature of content within a subject, the comparison is not really comparing like with like by ranking against the SOLO scores. Therefore, to be more reflective of a properly constructed test to compare similar items, namely the cognate skills specified by learning objectives, an adjusted scale based purely on the cognitive dimension by collapsing the knowledge dimension to a single integral value resulted in a scoring range between 1 and 6, where 1 was assigned to Remember and 6 was assigned to Create.

With two possible measuring instruments available, the question of how to determine an individual subject metric must now be answered. When reviewing syllabus learning objectives it becomes clear that many are framed in compound terms – that is to "do x and do y", or to "understand x, y, and z". The evaluation of compound objective statements can be resolved by one of three methods, namely

- to expand the compound statements into multiple simple statements, which in many instances would create a much longer list of objectives. The potential problem with this approach is that an objective of single intent but expressed in compound form would provide a doubling or tripling of scores, thus inflating the value of the objective.
- to evaluate the compound statement and average the individual parts that would be the simple statements under the expansion approach. In this method, the inflationary problem of the first method is overcome and it gives a score within the scaling range for the specific objective. This is the method that was adopted by Brabrand and Dahl.
- to use the maximum classification value obtained by inspecting the statement of the learning objective. While simplistic in nature, this method tends to err on the side of generosity when evaluating compound objective statements.

For consistency and comparison purposes it has been decided in this research to adopt the same approach as Brabrand and Dahl and use the 'double-weight averaging scheme'.

## 4. METHODOLOGY

In this study the syllabi for a degree in Information Technology were examined and rated in conjunction with the individual subject coordinators using both the SOLO Taxonomy and the revised Bloom Taxonomy scales. The average score for each objective was calculated when the objective was expressed in compound terms, and then an overall average was calculated for each subject. It was necessary to use a standardized item such as the average of the individual objective scores because different subjects list a different number of objectives. Accordingly, the average score would highlight the broad intentions of the subject on the cognitive scales. The relative weight of the subject is given in terms of its unit value, so this weighting was applied to the subject score to arrive at the year level aggregate.

The scores obtained were then grouped by the year level of the course to consider whether there were year level differences, and finally a score for the degree program was calculated.

In the particular degree program examined, there were three classes of subjects, the **Core** subjects which were compulsory, **Selective** subjects where students have a narrow choice from a limited list of subjects, and **Elective** subjects where students may choose from a broad range of subjects. A total of 20 syllabi statements were examined in this degree course to provide the data for the core and selective subjects. To effectively deal with the mix of subject types, the following rules were applied:

a) The compulsory subjects were evaluated as distinct entries;
b) The selective subjects were evaluated individually but the number of required selective subjects were included as cumulative average values. That is, where the course rule made a statement such as "include 2 of the following 5 subjects …", then the average score for the 5 subjects would be calculated and included twice to allow for the number required;
c) The elective subjects needed for each year level would be included as the average of the core subjects for that year level. The underlying assumption here is that the subjects across year levels within an institution may be considered as approximately similar in educational content even though they may come from different domain areas.

## 5. RESULTS

It is important to demonstrate the application of this methodology through an example. In the case study application, a three-year degree of Bachelor of Information Technology, there were 24 semester subjects required to complete the degree. Of these, there were 20 distinct subjects that were classified as core or selective subjects, with the remaining 4 being elective choices from a large range of options taken over different year levels. Taking as an example the first-year introductory subject "COMP1001 – Fundamentals of Computing", the behavioral objectives were listed as:

On successful completion of this subject, a student is expected to:

1. be familiar with the fundamentals, nature and limitations of computation
2. be familiar with standard representations of data and the translation to and from standard forms
3. be aware of the structure of information systems and their use
4. understand the social and ethical implications of the application of information systems
5. be able to construct simple imperative programs

In conjunction with the subject coordinator, the following assessments on the SOLO scale and Bloom scale were recorded:

**Table 6: Subject Assessment of Objectives**

| Objective # | SOLO Score | Bloom Score |
|---|---|---|
| 1 | S3 + S3 + S4 = 3.33 | B2 + B2 + B3 = 2.33 |
| 2 | 2 * S3 = 3.0 | B2 + B3 = 2.5 |
| 3 | 2 * S3 = 3.0 | 2 * B2 = 2.0 |
| 4 | S3 = 3.0 | B2 + B4 + B5 = 3.67 |
| 5 | S4 = 4.0 | B6 = 6.0 |
| **Average** | **3.27** | **3.30** |

The same process was followed for the other subjects in the degree and aggregated in a summary table where the subjects were grouped by year level, and weighted according to the unit value of the subject within the degree program.

For the three year Information Technology degree considered, the following summary of classifications for the subjects was obtained.

**Table 7: SOLO vs Bloom Scores**

| | Weighted SOLO Total | Adjusted Bloom Scores |
|---|---|---|
| First Year | 3.43 | 3.57 |
| Second Year | 3.56 | 3.63 |
| Third Year | 3.84 | 4.04 |
| Degree Total | 10.83 | 11.24 |
| Course Average | 3.61 | 3.78 |

## 6. DISCUSSION

In evaluating the behavioral objectives for the subjects in this degree there were several interesting points that were revealed. These are discussed as separate items below.

### 6.1 Appropriateness of a Taxonomic approach.

This paper has used two distinct taxonomic approaches, namely the revised Bloom Taxonomy and the SOLO Taxonomy, as vehicles to investigate the learning outcomes or objectives of the subjects in a particular course. The question of taxonomic appropriateness has been raised with respect to the use of Bloom's Taxonomy in the Computer Science domain [7]. In that work, Johnson and Fuller proposed a slightly different structure to cater for "the idea that application is the aim of computer science teaching." No firm resolution was given, but the issue of whether the Bloom Taxonomy is suitable in the computer science arena was raised. Other works have proposed that the revised Bloom Taxonomy was useful in Computer Science teaching, particularly where multiple staff members were involved in the subject [8]. Developments and research into a computer-science specific learning taxonomy have been undertaken by Fuller et al. [9] with a proposed model addressing the perceived deficiencies in both the Bloom and SOLO taxonomies. These research activities in concert with the Brabrand and Dahl efforts highlight and support that a taxonomic approach is relevant, even though the taxonomic tools currently available may not yet be the best fit, or may need some refinement for domain areas such as Computer Science. The experience gained in this study suggests that it may be more an issue of interpretation of the standard descriptors used in the classifications rather than changing the classification framework to suit the domain, otherwise one spawns a whole new set of taxonomies for various discipline domains, each of which then need to be validated.

### 6.2 Meaningful result.

The process applied in this research project has demonstrated that a statistic can be determined for a particular course of study. At this point the value of that statistic as an indicator to the academic rigor proposed for a course of study is yet to be proved, either with the SOLO Taxonomy or the Bloom Taxonomy. Subsequent work is required to provide comparative data and overall calibration for this metric. What has been revealed is that the closer analysis of the subject behavioral objectives for this degree across year levels does match the naïve expectations – namely that as one progresses through the degree studies from first year to second year to third year there is a shift of emphasis from the lower more functional or quantitative SOLO levels to the more sophisticated qualitative levels. The data in Table 7 demonstrates an increasing "SOLO Average" through the year levels, and provides a total of 10.83 for the course, or an average of 3.61 if one wanted to arrive at a single indicator figure within the scaling range. This finding is consistent with the findings of a separate study by Brabrand and Dahl [10] that explored the use of the SOLO Taxonomy to examine competence progression from undergraduate to graduate level studies. An almost identical result was obtained when using the Bloom Taxonomy, adjusted to consider only the cognitive elements. The fact of being able to establish a metric suggests that there is an opportunity to further develop a set of expanded tools that may be useful in the quality and benchmarking domain for degree courses.

### 6.3 Current written form of the statements of behavioral objectives.

The standard and consistency of the current behavioral objective statements was quite variable for this course. A significant number were quite vague and therefore difficult to classify appropriately. However, the vaguely expressed objectives were more easily classified using the Bloom Taxonomy than with the SOLO Taxonomy. The challenge for educational institutions is to ensure that the stated learning objectives accurately reflect what is being taught, what is being expected of students, and subsequently what is being learned in the subjects of the course.

### 6.4 Subjective nature of assessment of objectives.

A potential criticism of this approach is that the interpretation of behavioral objectives is subjective, and therefore suggests that repetition by different researchers would generate a different set of results. While there is some merit in this argument, it is defended by the confidence that we have in the professionalism of the people charged with making the assessment when they exercise their professional judgement. This is no different to examiners marking student papers, recognising that different examiners may arrive at slightly different final scores, but overall should return a similar result. Accreditation and benchmarking panels make subjective professional judgements based on the evidence presented to them when deciding to award particular achievement or status levels to courses.

### 6.5 Language-rich bias.

The subjects which have a stronger focus on language elements such as report writing and critiquing of subject materials tended to score more highly in both taxonomies. Some subject areas such as computer programming may involve quite complex levels of problem solving and formulation of creative approaches to resolve issues, but these elements were not explicitly stated in the subject learning objectives. Discussions with the subject coordinators highlighted that their impressions of some of the tasks required of the students involved the higher order taxonomy classifications, yet the subject learning objectives did not adequately express this.

### 6.6 Interpretation opportunities.

The two dimensional nature of the revised Bloom taxonomy makes subsequent investigation of comparative subsets somewhat more difficult computationally. On the other hand, the SOLO approach allows for more internal analysis to be undertaken with relative ease, as can be seen in the comparative distribution of SOLO levels across the degree in Figure 1. The data shown has been calculated by accumulating the number of objective elements stated at each of the SOLO levels for each of the years of study in the degree program, as indicated in Table 8.

**Table 8: Distribution of SOLO Levels across Degree**

| | Solo2 | Solo3 | Solo4 | Solo5 |
|---|---|---|---|---|
| First Year | 5% | 49% | 39% | 7% |
| Second Year | 7% | 41% | 42% | 10% |
| Third Year | 4% | 25% | 55% | 16% |
| Overall | 5% | 36% | 47% | 12% |

Using the adjusted Bloom scale to focus only on the cognitive dimension, a comparable set of data was obtained with the equivalent statistic listed as the Adjusted Bloom Score in Table 7, and the detailed breakdown is shown in Table 9 with the associated graphic in Figure 2.

While the proportions of objectives in each of the taxonomy classification levels across year levels appear as an interesting set of numbers in tables 8 and 9, it becomes patently clear in the graphical representation – Figure 1 and Figure 2 – that there is a distinct trend in the learning expectations in this course from the entry level at year 1 through to the final year program. In particular, it can be seen that there is a shift from the lower level learning activities based on simple recall and application of method through to the higher order analysis and evaluation required in critical thinking in later years.

**Table 9: Distribution of Bloom Levels across Degree**

| | Bloom1 | Bloom2 | Bloom3 | Bloom4 | Bloom5 | Bloom6 |
|---|---|---|---|---|---|---|
| First Year | 0% | 21% | 31% | 22% | 16% | 10% |
| Second Year | 6% | 14% | 26% | 20% | 22% | 12% |
| Third Year | 0% | 11% | 18% | 37% | 20% | 13% |
| Overall | 2% | 15% | 25% | 26% | 19% | 12% |

Example graphical analysis of the Information Technology degree considered in this study.

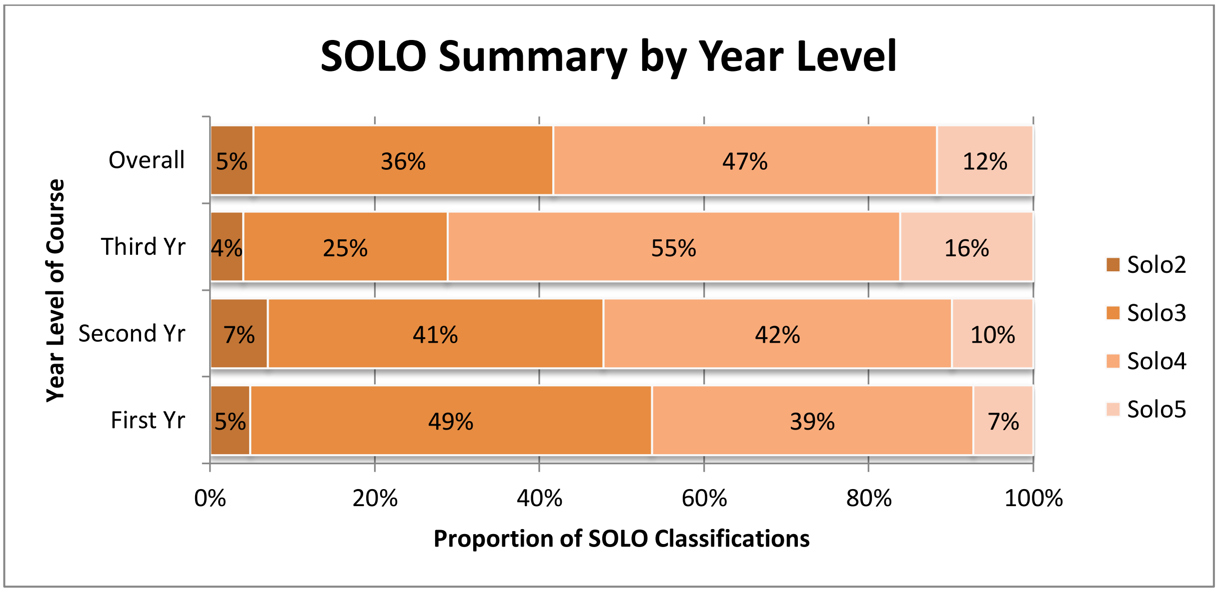


**Figure 1: Relative SOLO Levels in the Information Technology Degree**

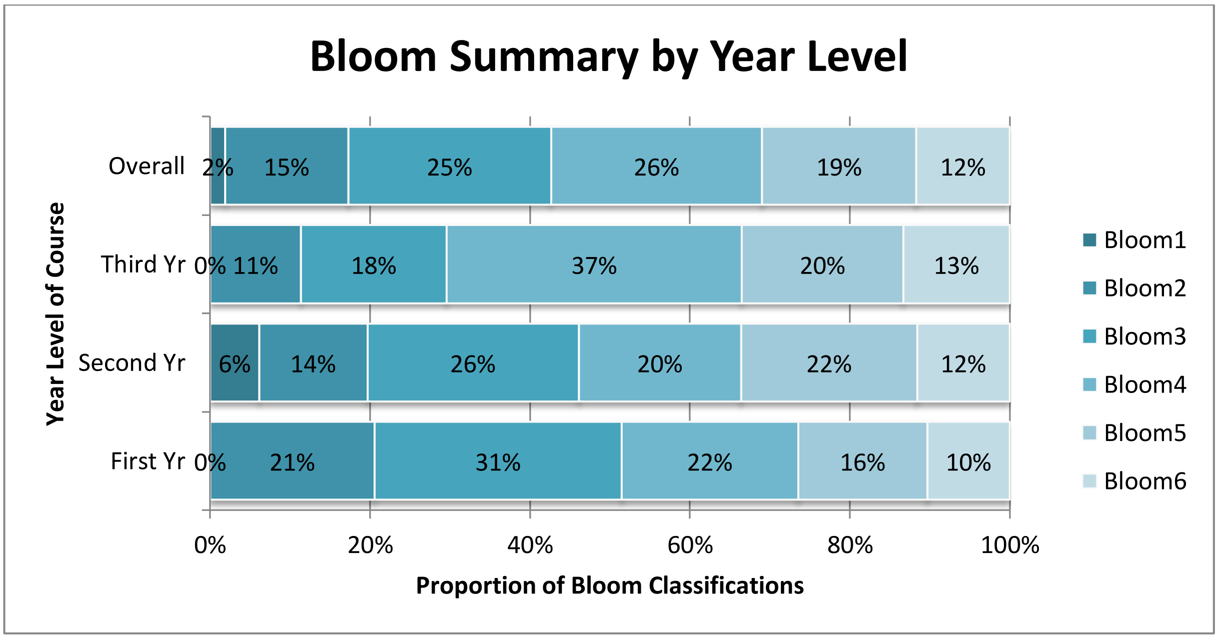


**Figure 2: Relative BLOOM Levels in the Information Technology Degree**

### 6.7 What then is the profile of this degree course?

The analysis undertaken demonstrates that there are several potential profiles that can be determined.

#### 6.7.1 Course Index Score

In the first instance, there is the Solo Average of 3.61, or the Bloom Average of 3.78 for this course. As indicators, these values propose that the overall course endeavors to go beyond basic learning activities of recall and application of standard methods and approaches, and ventures well into the qualitative realm of analysis and evaluation that would be expected of graduates able to display critical thinking attributes in their chosen field. Since the underlying nature of both the SOLO and Bloom taxonomies is cumulative, the equal-distance assumption in creating the basic scoring system for analyzing the subject objectives allows the interpretation of progression to higher levels in this manner. This can be represented on a graphical scale as shown in Figure 3, which indicates the positioning of the course score on a SOLO scale, and is labelled as a Course Index or C-Index.

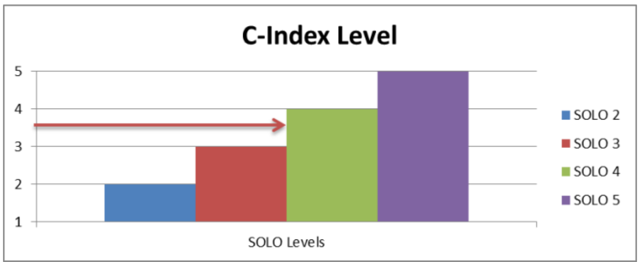


**Figure 3: Course Index Score**

#### 6.7.2 Overall or Summary Profile

Secondly, a more detailed profile for the course can be claimed if one simply takes the overall line of the graphic representation or the corresponding table. This particular profile lends itself to closer examination of the extent of academic rigor that is proposed for the course, namely 59% of the learning objectives are oriented towards the higher order qualitative tasks versus 41% being oriented towards the lower level quantitative tasks in the SOLO analysis, or 57% higher order and 43% lower order skills in the Bloom analysis.

The overall distribution of subject objectives in the various SOLO Classifications can be seen in the following charts as Figures 4 and 5. The representation in Figure 4 highlights that the most frequent behavioral objectives are at the SOLO 4 level (47%), which indicates a large concentration on analysis, comparison and evaluation, and application of theory within the course. To a lesser extent, the next most frequent classification is at SOLO 3 level (36%), indicating a substantial amount of the more routine tasks such as describing, classifying and performing known tasks.

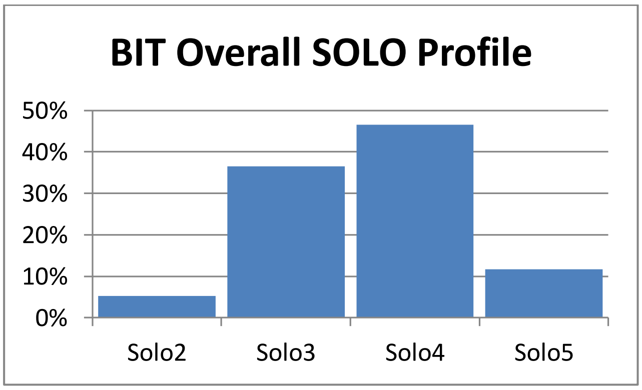


**Figure 4: Proportions of SOLO Classifications in BIT**

This same information can be seen in Figure 5, which is more like a one-line summary of the overall course composition, showing the relative proportions of SOLO classifications, and therefore learning outcome expectations for the course.

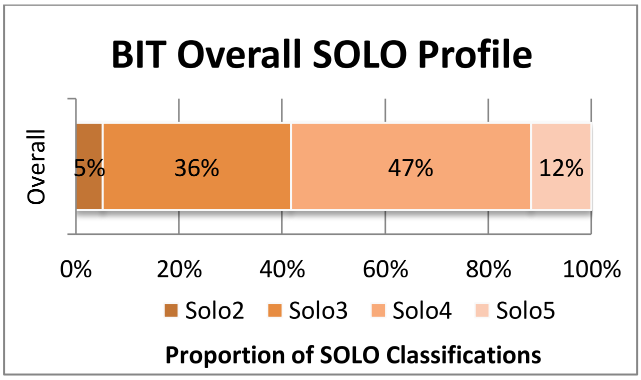


**Figure 5: Overall BIT Profile**

#### 6.7.3 Year-Level Profile

A third profile is achieved by examining the year-level breakdowns of learning intent. In this view the ratios of the different year level studies can be reviewed to ensure consistency with institutional goals and to validate against comparable courses to gauge the appropriate amount of different types of learning activity. For the course examined in this case study, it appears that each year level includes the objectives related to basic recall of factual material, but the major shift in focus seems to be from application of routine processes initially into more critical evaluation and analysis tasks in later years.

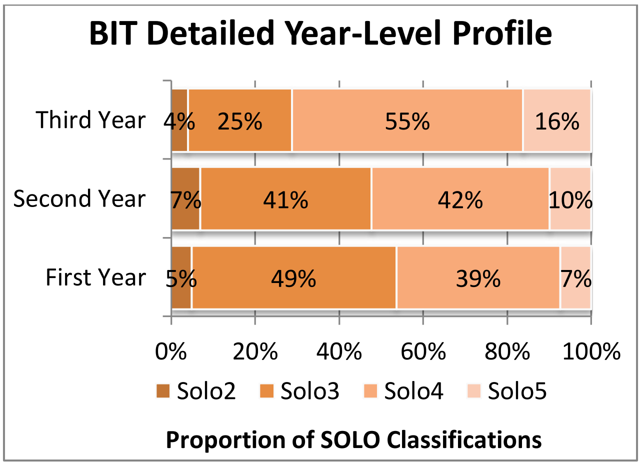


**Figure 6: Detailed Course Profile**

It is evident from the data displayed in Figure 6 that there is a substantial jump in those higher order objectives between year 2 and year 3 (19%) compared with the difference between year 1 and year 2 (6%). It is feasible to speculate on why this may be the case, whether by design or coincidence, and indeed could give course evaluators hints about empirically testing whether the implementation of the course matches the expected course rigor.

## 7. CONCLUSIONS

Traditionally it has been the case that teachers, academics and educators generally have rejected the notions of measurement and accountability in relation to the teaching process, even though they subject their students to exactly those elements. Many previous attempts at measurement of the education sector have been derived from administrators attempting to apply accounting principles which overlook many of the peculiarities of the education sector and invariably fail or invoke feelings of angst and hostility towards their implementation. This paper has introduced a concept for a metric that is systemic in nature, measuring attributes of the 'system' via the individual subjects that comprise a course of study, and ultimately generates a measure for the overall course of study. Being a pre-activity indicator it is independent of the approach taken by the teaching team and the peculiarities of the particular cohort of students. Individual academics have control over the attributes being measured in that they are the ones who write the behavioral objectives for their subjects and therefore contribute to the specifications for the subjects under their control as they have always done. The proposed value of this metric is that it should be used as an indicator of the educational rigor of the course examined. In such a context it may be used in a comparable manner to the 'degree of difficulty' factor previously discussed, and subsequently as a starting point for comparison of courses in future benchmarking processes.

One of the major findings of this research is that the standard of written behavioral objectives in the course examined was somewhat inconsistent. Some of the subjects had well-formed statements and made it clear about what was intended in the subject. Others were somewhat vague and provided minimal useful information about the subject content or intended student expectations. From an institutional perspective, a recommendation would be to tighten the statements of behavioral objectives to improve the subject specifications. With better and more consistent statements of objectives the key stakeholders who make use of those subject specifications will be better informed, and more reliable data based on those stated objectives may be obtained.

This research has demonstrated that it is feasible to construct a course profile for a degree using either the SOLO Taxonomy or the amended Bloom Taxonomy to evaluate the subject learning objectives for the course. Although the numeric values given in Table 7 are potentially useful indicators, the distribution of expected learning activity across year levels has proven to be much more interesting and informative when displayed either in tabular form (Table 8, Table 9), or graphically as in Figure 1 and Figure 2. The more specific graphical displays of subsets of the data in Figures 3 to 6 provide alternative forms of interpretation tools which may be used to examine courses from the broad overview level through to detailed year-level views. When used in conjunction with other examination tools and inspection of output artifacts, the profile of expected learning activities in the course should be a valuable instrument that finds application in course comparisons, benchmarking, and the evaluation of course quality.

The language-rich subjects tended to score higher in the methodology used in this research. Although this may be a slight impediment to the technically oriented courses, the overall influence of the language-rich subjects tends to be overshadowed by the inherent ratio of technical to less/non-technical subjects in structuring technically oriented degree programs.

There are many opportunities to extend the research associated with this work, including the expansion of the data sets involved, making decisions about the relative ease of working with each taxonomy, investigating the ways to better interpret the results obtained, and assessing the applicability of the approach in course benchmarking when different courses are compared.

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