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Analysis of Learning Outcomes of a Baccalaureate Degree Program in Construction Management

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This paper presents an analysis of the learning outcomes of a four-year baccalaureate degree program in construction management. The learning outcomes usually contain an action verb, a statement of the content to be learned and a description of the context of the learning. A textual analysis is performed to assess the distribution and frequency of occurrence of action verbs and to find most frequently occurring key words in the courses. The action verbs used in the learning outcome statements are tabulated in the schema of a revised Bloom's taxonomy. The analysis shows that although the action verbs can describe different cognition levels of the learners as they progress from 1st year to 4th year, the frequency of occurrence and distribution of the action verbs are not sufficient descriptors of the depth and breadth of the content covered. The analysis presents an approach that can be used to map learning outcomes of different courses and their correspondence with general learning outcomes of the program and to compare and standardize programs in construction management. The level of cognition and the content of cognition both are equally important when mapping courses within a program or using learning outcomes in benchmarking and standardizing two different programs.

Key Words: Learning outcomes, Bloom's Taxonomy, Action Verbs, Content, Construction Education

Introduction

Learning outcomes are used in education and training programs to outline the depth and breadth of the learning individuals are expected to achieve at the completion of the programs. A learning outcome is a statement that describes "the knowledge or skills students should acquire by the end of a particular assignment, class, course, or program" (Greenleaf, 2008, p. 3) and it refers to "the change in the learner's knowledge as a result of instruction" (Mayer, 2008, p.762). In other words, learning outcomes describe a knowledge or skill that learners acquire as a result of completion of the program which they did not possess previously (Watson, 2002). Moreover, a good learning outcome statement should describe, and help students understand why that knowledge and those skills will be useful to them. The learning outcome should guide the learners to interact efficiently with the content and should be stated in such a way that the degree of intended behavior achieved by the learners can be measured objectively.

Learning outcomes can be stated at the program level to "clarify the internal and lasting changes following program of instruction" (Richard, 2016, p. 9) and at the course level. Learning outcomes at the course level can be general learning outcomes which provide direction with respect to what is to be learned in a specific course or they can be specific learning outcomes which state what the learners should acquire at the completion of a topic, task, or assignment within the course. A learning outcome statement usually has three components – an action verb, a statement of the content to be learned and a description of the context of the learning.

One of the most widely discussed and applied frameworks in writing learning outcomes is Bloom's taxonomy of educational objectives. In a seminal work published in 1956, Bloom classified students' learning into various categories according to the level of cognition and grouped a range of action verbs in each cognition level (Bloom, 1956). One of the assumptions of Bloom's taxonomy is that the same classes of behavior are demonstrated by learners at various levels of education and in the context of a range of subjects and their contents. This universal applicability of the taxonomy has increased its popularity among the education developers and teachers at all levels of education from elementary school to higher studies and in a range of subjects from the liberal arts to applied education.

The origin of learning outcomes in education programs can be traced to the psychological school of behaviorism. Merriam and Bierema (2013) argue that "what has become known as evidence-based practice where in quantifiable, systematic, and observable "outcomes" are used as markers of learning and in turn used to structure learning activities is a behaviorist-oriented model" (p.27). Learning outcomes not only provide a framework for structured and student-centered learning, but they are also "a practical device and represent a methodological approach that has been adopted to improve the competitiveness, transparency, recognition and mobility" (Adam, 2006 p. 3). In addition to shifting the focus from input to output, Maher (2004) argues that learning outcomes-based curriculum development enhances employability, increases quality and accountability, and facilitates accreditation of learning. Because of globalization and mobility of the workforce, there is a growing need for education providers and accreditation bodies to evaluate and standardize courses and programs. Adam (2006) also argues that the outcome-based approach has applicability at national and international level for wider recognition and transparency of the programs and courses.

However, the applicability of learning outcomes and outcome-based approach in curriculum maintenance, mapping of course outcomes to program level outcomes and comparing different programs for accreditation and mobility purposes requires a deeper focus on the overall content of the learning outcomes rather than only on the action verbs. Bloom's taxonomy is intended to provide a classification of the cognition level but not the content that is cognized. As Bloom (1956) states "we are not attempting to classify the particular subject matter or content. What we are classifying is the intended behavior of students-the ways in which individuals are to act, think, or feel as the result of participating in some unit of instruction" (p.12). Although there have been extensive studies on the classification of the cognition level and associated action verbs, to the extent of author's knowledge there has been no study to associate the content vis-à-vis the cognition level especially in construction education. The purpose of this paper is to classify the action verbs used in the learning outcomes and to assess significance of the content in the learning outcomes in recognizing the level of cognition.

As such, this study has three specific objectives:

- Analyze the action verbs used in the learning outcomes of a 4-year construction project management program
- Map action verbs used in the learning outcomes according to Bloom's taxonomy
- Identify the importance of the learning content vis-a-vis the action verbs used in the learning outcome statements.

As a pilot study, this paper analyzes learning outcomes of an undergraduate program in construction management. Based on the outcome of this study, a comprehensive study of the course outlines of similar programs across North America is proposed as the next step.

Methodology

The course outlines used in this study are from a four-year baccalaureate degree program in Construction Project Management from a North American university. The program requires a total of123 credits to graduate. A student needs to complete 39 course works for 117 credits, a 600-hr internship of three credits and a capstone project of three credits. Out of the 39 course works, six are elective courses.

All the course outlines start with a brief description which outlines the general learning outcome of the course. The outlines usually list 10-12 learning outcomes each covering a distinct module or topic within the scope of the general learning outcome of the course. The learning outcomes are further divided into subtopics which are expressed as learning objectives. Each learning objective covers a unit or an activity which is stated with an action verb, a statement of the content to be learned and a description of the context of the learning as in the learning outcome statements. It should be noted here that although the distinction between learning objectives and learning outcomes is not universally recognized, literatures usually use learning objectives in the sense to describe the general learning outcome of a course (for example in Greenleaf, 2008) unlike in this case. Both learning outcomes and learning objectives are considered as learning outcomes in this study. A sample of a typical structure of a learning outcome statement and associated learning objective statements is presented in Figure 1.

Course Learning Outcome(s):
1. Identify civil, landscape, architectural, structural, mechanical, electrical and fabrication drawings in a set of construction drawings.
    Objectives
        1.1 List drawing views associated with each subset of construction drawings, such as plans, elevations and sections.
        1.2 Discuss the purpose of various drawings.
        1.3 Review phases of drawings which precede construction drawings.
        1.4 Assemble a complete set of construction drawings in standard order.
        1.5 Illustrate the relationships between various drawings, e.g., plans and sections, sections and elevations.
        1.6 Locate a specified building element on all drawings which has information relevant to that element.

Figure 1. A sample learning outcome and associated learning objectives from a typical course outline

A regular student takes 41 courses out of which six are elective courses, one is an Internship and one is a Capstone project. Although students have a choice in which elective they take from a pool of few electives, only one elective from each pool is included in this analysis. Internship is included as a 3rd-year course although students take Internship in between 3rd and 4th year. An open-source data mining tool Orange (Demsar et al., 2013) is used to perform text analysis of the 41 course outlines. Text analysis is used to create a structured data set from a corpus of text materials to analyze the patterns and trends. Text analysis is gaining popularity as an automated process to structure, visualize and comprehend the vast amount of textual data. Researchers in the field of education have also used text analysis in the past, for example, to assess students' motivation in online classes (Reich et al., 2014), to assess online discussion (Bettinger, Liu, & Loeb, 2016) and to analyze difference in responses to male and female students in online discussions in MOOC (massive open online courses) courses (Fesler et al., 2019).

The purpose of the text analysis in this study is to analyze learning outcome statements used in the course outlines. The output from the analysis is used to generate plots of commonly used words and phrases and to identify action verbs used in the course outlines.

Results from the Analysis of the Course Outlines

Word cloud diagrams of the frequently occurring works in the course outlines are presented in Figure 2a for each year and in Figure 2b for all the years (1st-4th year) combined. Few commonly occurring words such as objective(s), outcome(s), and capitalized words such as "Construction", "Project" and "Management" are filtered from the results as they are used in the name of the courses and name of the program too. However, the words construction, project and management starting with a small letter are retained as they form a part of the learning outcome statements as can be seen in Figure 1. Stop words and frequently occurring numbers have also been filtered from the output. Although words, such as explain, can be easily identified as an action verb, some words, such as research and design, can be a verb or a non-verb word. As the course outlines use a verb at the beginning of an outcome or an objective statement with a capital letter as seen in Figure 1, only words beginning with a capital letter are treated as an action verb.

Figure 2a. Frequently occurring words in the course outlines of 1st-year (top left), 2nd -year (top right), 3rd -year (bottom left) and 4th-year.

Figure 2b. Frequently occurring words in 1st to 4th-year courses

World cloud of 1st -year (Figure 2a) shows that "construction", "Calculate", "using", "Discuss", "project", "Identify" and "Describe" are the most frequently occurring words. Word cloud of the 2nd-year courses also shows similar words as in the 1st-year courses but there are few additional words such as "structural", "design", "soil" which are related to civil engineering subjects. In 3rd and 4th-year course outlines, "project", "management", "Explain" and "research" start appearing more frequently. "Identify", "project", "construction", "Explain", "Describe", "management", "Discuss" and "systems" are some of the words that occur frequently in course outlines from 1st-year to 4th-year (Figure 2b).

Table 1

List of top ten most frequently occurring verbs in learning outcomes

1st Year	Frequency	2nd Year	Frequency	3rd Year	Frequency	4th Year	Frequency
Calculate	70	Explain	86	Explain	82	Explain	89
Describe	63	Identify	79	Describe	71	Identify	69
Identify	57	Describe	60	Identify	67	Discuss	53
Discuss	48	Determine	40	Define	51	Recognize	33
Explain	39	Discuss	35	Review	39	Define	31
Outline	37	Calculate	32	Discuss	36	Analyze	30
Determine	35	Recognize	27	Develop	33	Examine	28
Solve	33	Define	26	Examine	32	Apply	27
Analyze	32	Apply	22	Analyze	31	Review	26
Define	31	Estimate	20	Outline	30	Describe	24

The plots show that the concept of "management" starts to occur more frequently in the course outlines after 2nd year whereas "construction" is present in the outlines from 1st-year. A separate list of ten most frequently occurring action verbs is shown in Table 1. The action verbs "Calculate" and "Solve" in 1st-year indicate that the focus of 1st-year courses is on foundational subjects of mathematics and physics. Furthermore, 2nd-year courses have more focus on technical subjects related with the field of civil engineering as demonstrated by the presence of words such as "structural", "design", "surveying", and "soils". The course outlines have more prominent presence of words "safety", "risk" and "health" in 3rd-year courses. Fourth-year courses start to show the presence of the words "industry", "research", and "quality".

The action verbs and their normalized occurrence frequency are plotted in Figure 3. Normalized frequencies are plotted on the horizontal axis and vertical axis shows different years. Normalization for

each year is done using total number of courses in that particular year. A verb appearing on the right side is more frequently occurring than one on the left side. The program has ten courses in each year except in the 3rd-year which has 11 courses as Internship is included as a 3rd-year course in this study. For example, the normalized frequency of action verb "Calculate" in 1st-year is 70/10 (=7.0) and in 2nd Year is 32/10 (=3.2) which are shown in Figure 3 in the line of 1st-year and 2nd-year, respectively. Normalization of the plot for "All Years" shown in Figure 4 is done by dividing the sum by 41. For example, as the action verb "Explain" occurs 296 in total, the normalized frequency for "Explain" in the category of "All Years" is 296/41 (=7.2).

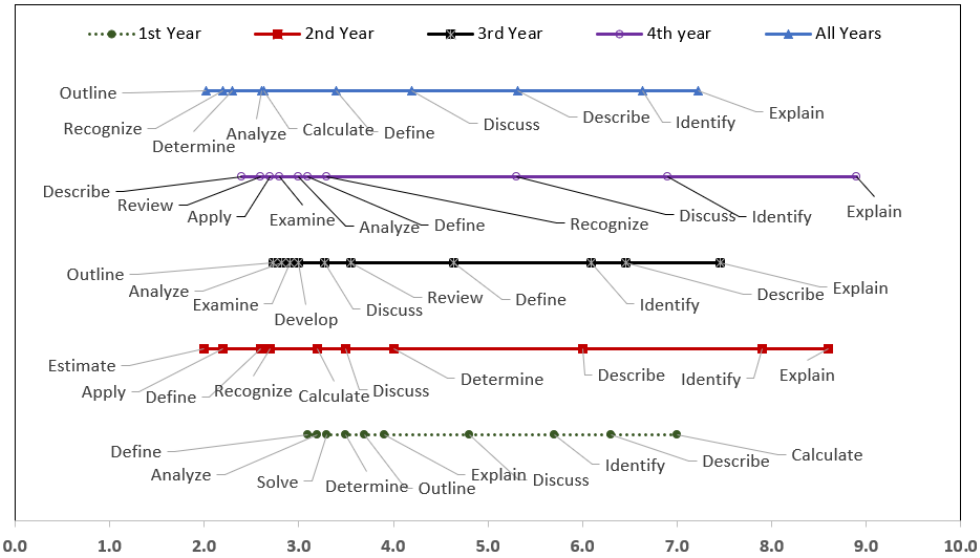

Figure 3. Plot of the top 10 frequently occurring action verbs in course outlines normalized with number of courses

The plot shows that action verbs "Explain", "Describe", and "Identify" are most commonly occurring action verbs in the course outlines with each verb occurring in each course outline at an average frequency of 7.2, 6.6 and 5.3, respectively.

Action Verbs and Bloom's Taxonomy

Education and trainings are concerned with bringing about changes in individuals and learning outcome are used to define the changes (Maher, 2004). As Bloom's taxonomy is the most widely used framework for classifying learning in cognitive terms and is the framework used to design outcome-based courses globally (Maher, 2004; Coates, 2000), this study uses revised Bloom's taxonomy as a framework to map the action verbs used in the learning outcomes. The verbs used in learning outcomes are action words that "describe the cognitive processes by which thinkers encounter and work with knowledge" (Armstrong, 2010). Bloom's taxonomy, a framework developed by Bloom and his colleagues in 1956, is widely used to categorize the action verbs into a continuum from simple to complex and concrete to abstract. The original taxonomy has been critiqued, revised, and updated by many scholars. For this study, a revision suggested by Patricia Armstrong from the Center for Teaching, Vanderbilt University (Armstrong, 2010) is used (Figure 4). The revised taxonomy has six categories – remember, understand, apply, analyze, evaluate, and create. Remember is the lowest cognition level which involves recalling

of facts and basic concepts and create is the highest cognition level which involves producing an original work.

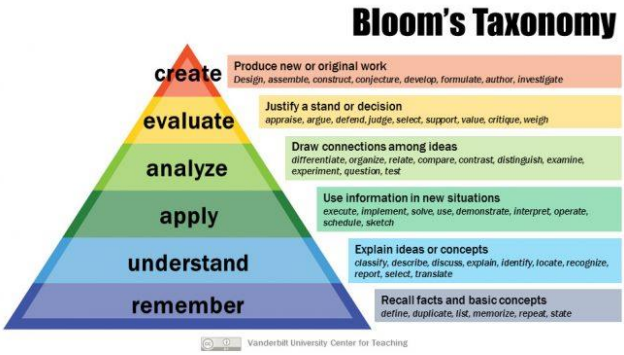

Figure 4. Revised Bloom's taxonomy from Armstrong (2010)

The top ten most frequently occurring action verbs used in the course outlines are tabulated in Table 2 along with revised Bloom's classification. It can be observed a large number of frequently occurring verbs in the course outlines fall under the category of "Understand" which is the second level of cognition in the revised Bloom's taxonomy (Figure 4). "Apply" is a category of higher order of cognition in Bloom's taxonomy and 1st-year and 2nd-year courses have many verbs in this category too. "Analyze" and "evaluate" are next higher order categories and 3rd-year and 4th-year courses have many verbs from this category.

Table 2

Categorization of the top ten frequently occurring verbs according to Bloom's taxonomy

Bloom's category	1st Year	2nd Year	3rd Year	4th Year	All Years
Remember Understand	Define Describe, Discuss, Identify, Explain, Outline	Define Describe, Discuss, Explain, Identify, Recognize	Define Describe, Discuss, Explain, Identify, Outline	Define Describe, Discuss, Explain, Identify, Recognize	Define Describe, Discuss, Explain, Identify, Outline, Recognize
Apply	Calculate, Determine, Solve	Apply, Calculate, Determine, Estimate		Apply	Calculate, Determine
Analyze	Analyze		Analyze, Review	Analyze, Review	Analyze
Evaluate			Examine	Examine	
Create			Develop		

"Create" is the highest order cognition in Bloom's taxonomy which includes verbs with the connotation of producing new or original work. Only one verb "Develop" appears as one of the top 10 frequently used verbs from this category. "Develop" is the 7th most frequently used verb in 3rd-year course outlines which is used 33 times in 11 courses with an average of three occurrences in each course (Figure 3).

To analyze the lack of higher cognitive level verbs in the course outlines, particularly in the senior year courses, occurrence of the verbs in this category is tabulated separately in Table 3. Numbers in parentheses indicate the number of occurrences of the verb in the course outlines. As these verbs are not among the top 10 frequently occurring verbs, they do not appear in Table 1.

Table 3

Tabulation of action verbs in "Create" category. Number in parenthesis is frequency of the verb.

Bloom's category	1st Year	2nd Year	3rd Year	4th Year
Create	Design (1), Develop (1), Investigate (1), Formulate (1)	Design (15), Develop (6)	Develop (33), Design (12)	Develop (10)

Although verbs in the "Create" category do not appear among the list of ten most frequently occurring verbs in 1st, 2nd and 4th year courses, the tabulated results show that verbs in this category are present in the course outlines in all years (Table 3). First-year courses use "Design", "Develop", "Investigate", and "Formulate" once each. Second-year and 3rd-year courses use "Design" 27 times and "Develop" 39 times in total. Fourth-year courses use "Develop" 10 times and "Investigate" and "Construct" twice and once, respectively. The results show that the number of verbs in the "Create" category increases from 1st to 3rd-year but the number decreases in the 4th-year courses.

To investigate the reason for the less frequent occurrence of higher cognition level verbs in the 4th-year course outlines, the learning outcome statements are further investigated. Instead of looking at the action verbs only, complete statements with action verbs, content and context are reviewed. Although two courses may use the same action verb, the depth and breadth of the learning may be different depending upon the content and condition that follow the action verb. Following two learning outcome statements are used as an example to illustrate this argument.

- Learning objective from a 1st-year course - Develop solutions to problems of inaccuracies in drawings.
- Learning objective from a 4th-year course - Develop the final project report [of a construction research project].

Although both learning objectives have "Develop" as an action verb, 1st-year students are "Developing" solutions for eliminating errors in drawings but 4th-year students are "Developing'" a report based on an actual research project. The content of the latter is obviously more complex and expects a higher level of sophistication from the learners. Therefore, it can be argued that the action verbs are necessary but not sufficient to represent the depth and breadth of the intended learning. In mapping course learning outcomes with program learning outcomes and in comparing two different programs, a complete analysis of the laddering of the action verbs from first year to final year should be accompanied by the analysis of the content and context associated with the action verbs. The level of cognition and the content of cognition both are equally important when mapping courses within a program or using learning outcomes in benchmarking and standardizing two different programs.

Conclusion

Learning outcomes focus on outputs as measured by changes in skills or knowledge rather than on inputs such as number of hours taught and amount of the course covered. Because of their focus on the learners, learning outcomes represent "a more realistic and genuine measure of the value of education

than measures of teaching input" (Maher, 2004 p. 47). Using textual analysis of the learning outcomes of the courses in a typical baccalaureate degree in construction management in North America, this study shows that mapping of distribution and frequency of occurrence of the action verbs can be used to assess expected progression from lower to higher cognition level in the Bloom's taxonomy. Moreover, the results show that action verbs are necessary but not sufficient indicators to assess the level of learning expected from the learning outcome statement. Learning outcomes usually have three parts – an action verb, content of learning and context of learning. Although level of cognition is determined by the action verb, the analysis shows that the content and the context of a learning are equally important components to map the extent of the expected learning.

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