Collaborative Analysis and Revision of Learning Objectives

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Abstract

The purpose of this study was to report on the employment of Bloom's revised taxonomy as a means to describe, assess and revise the learning objectives postsecondary instructors operationalized in their classroom and laboratory instruction. The study uses an example case to describe a generalizable process for assessing learning objectives instructors use within classroom instruction. The example case illustrates that 74% of the specified learning objectives utilized in classroom instruction by 26 instructors were characterized as addressing primarily lower order cognitive processes. The described method of assessing learning objectives is intended to assist instructors in two ways: 1) To help them gain a deeper understanding of the learning objectives they are employing and 2) To provide guidance for constructing and revising learning objectives so that they require higher order levels of cognition from students.

Introduction

Postsecondary students entering the workforce face many challenges in finding pathways to success (Alfeld et al., 2006). The prosperity of entry level professionals in the global market will erode unless educational systems can assist students in developing valued knowledge and skills along with a deep capacity to learn, solve problems and adapt to novel work and entrepreneurial environments. However, in order for students to achieve great heights, they must first be able to master foundational academic content which requires multiple levels of cognitive processing and utilizes a range of knowledge dimensions (Archambault, 1964; Knobloch, 2003).

The process of engaging students in meaningful high utility learning opportunities should begin with a clear specification of educational goals and objectives (Hoachlander, 1999). Explicitly aligning learning activities with well written goals and objectives will help to ensure that learning activities and assessments are focused and germane to the academic and career challenges students will face in the future (Blumberg, 2009). Moreover, if instructional goals and objectives are structured and organized appropriately, learning activities are contextualized and will support the acquisition of a range of knowledge types which include a variety of cognitive processing levels (Blumberg, 2009).

Bloom's revised taxonomy (Anderson et al., 2001), is a refinement and extension of original work by Benjamin Bloom (1956). Bloom's original work is an often cited and utilized tool for classifying educational objectives based on what instructors expect their students to learn and be able to do (Fink, 2003). Bloom's revised taxonomy was constructed by one of his protégés and several colleagues. The revised taxonomy is considered to be an effective tool for writing, organizing and analyzing learning goals and objectives (Blumberg, 2009). Bloom's revised taxonomy (Anderson et al., 2001) allows researchers and educators to conceptually chunk large amounts of complex information in order to bring more precision to applied practice. One of the critical strengths of the revised taxonomy is that it can be employed as a syntactic logic tool at the macro level for curriculum planning and program assessment and at the micro level for lesson planning and student assessment (Cannon and Feinstein, 2005).

In the revised taxonomy, learning objectives can be described and represented using a two-dimensional taxonomic table (Anderson et al., 2001). Table 1 illustrates the four dimensions or types of knowledge that are categorized on the vertical axis within the two-dimensional taxonomic table of the revised taxonomy and Table 2 illustrates the six levels of cognitive processing that are illustrated on the horizontal access of the table. The intersection of the four categories of the knowledge dimension and six categories of the cognitive process dimension form twenty-four discrete cells which afford educators the opportunity to more precisely classify learning objectives based upon the specific facets of the intersecting dimensions. (Krathwohl, 2002).

Table 1 demonstrates that within Bloom's revised taxonomy (Anderson et al., 2001) the four types of knowledge are: a) factual; b) conceptual; c) procedural; and d) metacognitive. Factual knowledge is considered to be knowledge of terminology, facts and basic elements of more complex knowledge, e.g., people,

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Table 1. The Structure of the Knowledge Dimension of Bloom's Revised Taxonomy

A. Factual knowledge: The basic elements students must know to be acquainted with a discipline or solve problems within it.
Aa. The knowledge of terminology
Ab. The knowledge of specific details and elements
B. Conceptual knowledge: The interrelationship among the basic elements within a larger structure that enable them to function together.
Ba. Knowledge of classifications and categories
Bb. Knowledge of principles and generalizations
Bc. Knowledge of theories, models, and structures
C. Procedural knowledge: How to do something, methods of inquiry, and criteria for using skills, algorithms, techniques, and methods.
Ca. Knowledge of subject-specific skills and algorithms
Cb. Knowledge of subject-specific techniques and methods
Cc. Knowledge of criteria for determining when to use appropriate procedures
D. Metacognitive knowledge: Knowledge of cognition in general as well as awareness and knowledge of one's own cognition.
Da. Strategic knowledge
Db. Knowledge about cognitive tasks, including appropriate contextual and conditional knowledge
Dc. Self-knowledge

Note. Adapted from Anderson, et al. (2001). p. 29.

events, locations, or dates (Anderson et al., 2001). Conceptual knowledge reflects a deeper understanding of content and how it is connected to larger systematic perspectives (Blumberg, 2009). Procedural knowledge often involves processes or methods and the criteria utilized to make decisions regarding key steps and procedures (Anderson et al., 2001) Metacognitive knowledge involves being self-aware of personal cognitive strengths and challenges. Metacognitive knowledge is also related to knowledge of general strategies for learning and knowledge about how, when and why to employ particular learning strategies (Blumberg, 2009).

Table 2 illustrates that within Bloom's revised taxonomy (Anderson et al., 2001) the six levels of cognitive processing form a hierarchy based upon differences in complexity and range from least complex to most complex: 1) remember; 2) understand; 3) apply; 4) analyze; 5) evaluate; and 6) create (Anderson et al., 2001). The revised taxonomy lists additional verbs within each of the six levels which more clearly delineate their nature. For example, level two titled understand, includes more measureable verbs such as interpret, classify and compare. In particular, it is the measureable verbs that more precisely characterize the breadth and depth of each of the cognitive process levels.

Methodology

The purpose of this study was to report on the employment of Bloom's revised taxonomy as a means to describe, assess and revise the learning objectives postsecondary instructors operationalized in their classroom and laboratory instruction. The target population for the study was 26 postsecondary instructors working within a university system in a North Eastern state that took part in a two day institute. The participants of the study worked in range of 2-year and 4-year institutions and specialized in a variety of science based fields of study. The State University of New York at Oswego Human Subjects Committee approved the study protocol and all participants provided written informed consent prior to their participation in the study.

Institute participants were organized into cooperative learning groups of three to four people and assigned several goal oriented tasks. The first tasks included each instructor describing to the rest of their cooperative learning group the scope and sequence of the learning objectives they utilized within one of their courses of study. The second layer of tasks involved the cooperative groups employing Bloom's revised taxonomy to collaboratively analyze the learning objectives each individual instructor utilized within the course they had previously described. The third layer of tasks directed the cooperative groups to organize and analyze the learning objective data to look for trends and interesting bits of information. The fourth layer of tasks included the cooperative groups working collaboratively to adapt and revise each individual instructor's learning objectives in order to: a) structure a better sequencing of topics; b) promote higher levels of student cognition; and c) effectively align learning objectives with pertinent departmental and campus priorities and assessment strategies. The fifth layer of tasks asked the instructors to utilize Bloom's revised taxonomy to collaboratively reanalyze the learning objectives of each individual again to assess the level of change that occurred throughout the process.

The second and fifth layer of tasks which involved the cooperative groups utilizing Bloom's revised taxonomy to analyze their learning objectives merit a closer examination. The members of the cooperative groups first individually reviewed their collaborators' learning objectives. The individual reviews allowed for overlap and a check of inter-coder reliability. Table 3 illustrates the taxonomic

Table 2. The Structure of the Cognitive Process Dimension of Bloom's Revised Taxonomy

1.0 Remember: Retrieving relevant knowledge from long-term memory.
1.1 Recognizing, identifying
1.2 Recalling, retrieving
2.0 Understand: Constructing meaning from instructional messages including oral, written, and graphic communication.
2.1 Paraphrasing, translating
2.2 Interpreting, illustrating, instantiating
2.3 Classifying, categorizing, subsuming
2.4 Summarizing, abstracting, generalizing
2.5 Inferring, concluding, extrapolating
2.6 Comparing, contrasting, matching
2.7 Explaining, constructing models
3.0 Apply: Carrying out or using a procedure in a given situation.
3.1 Executing, performing
3.2 Implementing, carrying out
4.0 Analyze: Breaking material into its constituent parts and determining how the parts relate to one another and to an overall structure or purpose.
4.1 Differentiating, discriminating, distinguishing
4.2 Organizing, integrating, structuring
4.3 Attributing, deconstructing
5.0 Evaluate: Making judgments based on criteria and standards.
5.1 Checking, detecting, monitoring, testing
5.2 Critiquing, judging
6.0 Create: Putting elements together to form a novel, coherent or functional whole; reorganizing elements into a new pattern or structure.
6.1 Generating, hypothesizing
6.2 Planning, designing
6.3 Producing, constructing

Note. Adapted from Anderson, Krathwohl, et al. 2001. p. 67-68.

table that the instructors used, in conjunction with the information reflected in Tables 1 and 2, to classify the learning objectives provided by each instructor. One of the central strengths of the taxonomic table is that it provides a framework for describing learning objectives by the type of knowledge to be gained and the cognitive process employed to facilitate the actual learning. Classifying each instructor's learning objectives using the taxonomic table provided a visual map that the cooperative groups could use to assess the arrangement and effectiveness of their learning objectives.

In order to use Bloom's revised Taxonomy it is necessary to understand that any individual learning objective will fall under one of the six discrete categories of cognitive processing and at the same time will also be linked to one of the four discrete categories of knowledge dimension. The object in a learning objective statement is used to determine whether the learning objective is supporting factual, conceptual, procedural, or meta-cognitive knowledge acquisition. The verb in a learning objective statement is used to determine which cognitive process dimension is being applied in the learning process: remembering, understanding, applying, analyzing, evaluating, or creating.

Once the knowledge and cognitive process dimensions are determined, learning objectives can be correctly placed in the taxonomic table. Learning objectives placed in the upper left hand corner of the taxonomic table tend to be more concrete, simple, structured and require less learner independence. And as the taxonomic niches traverse the table diagonally toward the lower right hand corner the learning objectives tend to be more abstract, complex, open, multifaceted and require greater learner independence. Table 4 provides a conceptual illustration which depicts the increasing relative complexity of the learning objectives niches as they traverse the table from the upper left to the lower right hand corner. Complexity is not only increased by the number of elements which must be cognitively processed, but also the connections between those elements.

It may be beneficial to provide several examples in order to more clearly delineate the process enacted by the instructors to classify each of the learning objectives. To that end, Table 5 illustrates three example learning objectives that were classified within the process of the research study. For brevity only the essential elements of the example objectives are presented.

Table 5 illustrates that the object in learning objective one was as follows: the 16 essential elements all plants need for life, growth and reproduction. Learning objective one required learners to demonstrate a type of knowledge that represents a basic building block which would be utilized in the construction of different types of knowledge. More specifically the object of the learning objective sentence required students to demonstrate knowledge of technical vocabulary, a type of factual knowledge. Therefore, learning objective one was classified as being within the factual knowledge category of the knowledge dimension of Bloom's revised taxonomy.

Table 5 demonstrates that the verb in learning objective one required learners to identify information. In this case, to identify the required information depends only on the learners' ability to recognize or recall, therefore, learning objective one was classified as being within the remember category of the cognitive process dimension of Bloom's revised taxonomy. Once both dimensions of a learning objective have been classified it can be placed into one of the 24 cells created by the intersection of the knowledge and cognitive process dimensions of the taxonomic table illustrated in Table 3. Using Table 3 as a guide, objective one would most appropriately be placed in cell A1 at the upper left hand corner of the taxonomic table.

Table 5 illustrates that the object in learning objective three was as follows: the efficacy of an algorithm based on real-time data. The object of the learning objective sentence required students to demonstrate knowledge of subject specific techniques, as well as, knowledge of criteria for determining when to use appropriate procedures. Therefore, learning objective three was classified as being within the procedural knowledge category of the knowledge dimension of Bloom's revised taxonomy.

Table 5 demonstrates that the verb in learning objective three required learners to evaluate situations based upon data. In order to demonstrate the ability to complete the required evaluations learners must be able to enact appropriate interpretation and appraisal techniques that lead to accurate judgments. Therefore, learning objec-

Table 3. A two-dimensional illustration of the relationship between the knowledge and cognitive processing dimensions of Bloom's revised taxonomy

	Cognitive Process Dimension					
Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	A1	A2	A3	A4	A5	A6
Conceptual	B1	B2	B3	B4	B5	B6
Procedural	C1	C2	C3	C4	C5	C6
Metacognitive	D1	D2	D3	D4	D5	D6

Note. Adapted from Krathwohl, 2002. p. 216.

Table 4. A two-dimensional conceptual illustration of the complexity of the cognitive process dimension increases from left to right

	Cognitive Process Dimension					
Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual						
Procedural						
Metacognitive						

Note. Adapted from Krathwohl, 2002. p. 216.

Table 5. Example learning objective statements and their classifications

	Learning Objective Statement	Classification
1	Identify the 16 essential elements all plants need for life, growth, and reproduction	A1
2	Analyze the relationship between the design of a technology and its impact on the surrounding systems	B4
3	Evaluate the efficacy of an algorithm based on real-time data analysis procedures	C5

Table 6. A classification of the learning objectives instructors operationalize in their classroom

	Cognitive Process Dimension					
Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	[1]28	13	10	14	2	*
Conceptual	6	3	4	8	*	*
Procedural	4	3	2	*	*	+
Metacognitive	+	+	+	+	+	+

Note. [1] Percent of the overall total number of objectives in classification rounded to the nearest whole number. * The percent of the overall total number of objectives is equal to less than 0.50. + No objectives in classification.

Table 7. A classification of the revised and adapted learning objectives

	Cognitive Process Dimension					
Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	[1]7	5	8	7	8	6
Conceptual	5	4	4	5	3	6
Procedural	3	5	2	7	5	5
Metacognitive	+	+	1	2	2	+

Note. [1] Percent of the overall total number of objectives in classification rounded to the nearest whole number. * The percent of the overall total number of objectives is equal to less than 0.50. + No objectives in classification.

tive three was classified as being within the evaluate category of the cognitive process dimension of Bloom's revised taxonomy. Utilizing Table 3 as a guide, objective three would most appropriately be placed in cell C5 at the lower right hand corner of the taxonomic table.

In the example study a percent agreement method was employed as a means of estimating inter-coder reliability. The ratings of each individual instructor were compared to the ratings of each other individual instructor within their cooperative group, all of the inter-coder reliability estimates were found to be equal to or greater than 0.97 (Perhaps include the name of procedure used, e.g. Cohen's kappa). In cases where discrepancies were noted, the classifications were determined by consensus discussion.

Results/Findings

The purpose of this study was to report on the employment of Bloom's revised taxonomy as a means to describe, assess and revise the learning objectives instructors operationalized in their classroom instruction. The 26 instructors participating in the example study had an average of 218 (SD= 29.2) students per year and taught an average of 4.8 classes (SD=1.1) a year. A slight majority of the instructors were male (62%) and (70%) of the instructors had a doctoral degree.

The current study used Bloom's revised taxonomy (Anderson et al., 2001) as part of a method for describing and assessing the learning objectives postsecondary instructors use within classroom and laboratory instruction by knowledge dimension and cognitive process simultaneously. Table 6 provides a summary of the data associated with carrying out the assessment of the learning objectives and an illustration of Bloom's revised two-dimensional taxonomy. Table 6 also provides an overarching perspective regarding the types of learning objectives the instructors have implemented in their classroom instruction.

Table 6 reveals that very few of the learning objectives reviewed were designed to support abstract, complex, open, or multifaceted learning opportunities that require greater learner independence and higher levels of cognitive processing. Table 6 also demonstrates that a substantial majority (74%) of the learning objectives described and assessed were designed to elicit lower order cognitive processes and 71% of those objectives were characterized as addressing lower order cognitive processes focused only on the factual category of knowledge. The information presented in Table 6 demonstrates that there were slightly more learning objectives classified as conceptual then there were objectives classified as procedural within the knowledge dimension of Bloom's revised taxonomy. That indicates that the instructors placed some emphasis on both conceptual understanding and actually executing appropriate techniques and procedures using learned skills.

Part of the generalizable process delineated in the current study included the cooperative groups of instructors collaborating to revise the learning objectives they had initially described and assessed. [My preference is to state that the data in a particular table illustrates or indicates, not the table itself] Table 7 illustrates the information that resulted from the revision and reassessment of the original learning objectives the cooperative groups of instructors started with at the beginning of the process. Table 7 reveals that the revision process resulted in a more even distribution of level learning objectives across a range of cognitive process and knowledge dimensions.

Data presented in Table 7 delineates that after the collaborative revision process only 44% of learning objectives described and assessed were designed to elicit lower order cognitive processes and only 45% of those objectives were characterized as addressing lower order cognitive processes focused within the factual category of knowledge. Table 7 illustrates that the cooperative revision process lead to an increase in the number of learning objectives that emphasized conceptual and procedural dimensions of knowledge at higher cognitive processing levels. Table 7 also reveals that the cooperative revision process assisted instructors to adapt existing or create new learning objectives that were classified as being within the metacognitive knowledge dimension category. Metacognitive objectives refer to students' awareness of their own knowledge and ability to understand and manipulate their own learning processes. Objectives in this category most frequently required students monitor their degree of understanding or reflect on their problem solving strategies or outputs.

Conclusions/Implications/Recommendations

The purpose of this study was to report on the employment of Bloom's revised taxonomy as a means to describe, assess and revise the learning objectives instructors operationalized in their classroom and laboratory instruction. The study used a generalizable example to illustrate the processes and included the data that resulted from enacting the process with 26 instructors. The central conclusion of this research was that the generalizable process was an effective means of assisting the instructors to create a greater diversity of learning objectives that addressed a wider range of cognitive process and knowledge dimensions. Further the cooperative process effectively helped instructors to create higher order learning objectives that went well beyond the simple memorization of facts. Meaning is added to this finding when attention is given to the idea implicit within higher order learning objectives is the requirement to remember and understand: a) factual; b) conceptual; and c) procedural knowledge.

Employing Bloom's revised taxonomy and particularly the taxonomic table was an effective method for assisting instructors to create a visual representation of the learning objectives they employed within their teaching. It was also a useful way to help them think about revising the learning objectives they used in order to create learning opportunities that required more abstract, complex, open, multifaceted and independent cognitive operations. In addition, the employment of the cooperative groups assisted the instructors in: a) initially describing and assessing their learning objectives; b) revising and adapting their learning objectives; and c) reassessing their learning objectives. In an age of increasing accountability, it is useful to have such a simple and effective means of illustrating the rigor of the learning objectives that are being operationalized in classrooms and laboratories.

It is recommended that instructor development professionals and providers of professional development use the generalizable process described in this study to assist instructors to carefully design or revise their instructional objectives. Instructor development professionals and providers of professional development may also want to consider implementing instruction for instructors that emphasizes the importance of using frameworks, such as, Bloom's revised taxonomy to construct and organize student learning opportunities. An emphasis should be placed on creating and utilizing learning opportunities that pass beyond rote memorization and move students towards learning how to address novel challenges and developing as self-aware innovators.

It is suggested that instructors examine the course, unit and lesson level learning objectives they utilize to make sure they address a range of knowledge and cognitive processing categories. It is recommended that instructors seek professional development opportunities to extend their content and pedagogical related knowledge and expertise so that they may expand their teaching repertoire. It is also recommended that instructors connect with other instructors to explore collaborative methods for developing and revising learning objectives.

Further research on the employment of cooperative groups to strengthen the professional practice of individual instructors is warranted. Cooperative learning as a method of instruction has demonstrated robust efficacy across a range of ages and cultural contexts, it is likely that it would be well suited for instructor professional development (Johnson and Johnson, 2009).

More specifically, it is recommended that research be carried out to create information about how instructors could best utilize the process describe in this study with colleagues or cooperative groups within their own institution. To extend knowledge in a slightly different direction research could be carried out to analyze whether the knowledge and cognitive processing classification dimensions of learning objectives correlate with the enactment of appropriate research based teaching and assessment methods. Based on the very low percentage of metacognitive learning objectives it is also recommended that further research examine instructors' awareness and perception of metacognition as an element of learning and as a dimension within Bloom's revised taxonomy.

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