Guidelines for using Bloom's Taxonomy Table as Alignment Tool between Goals and Assessment

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Abstract. In academia lecturers are often appointed based on their research profile and not their teaching and learning (T&L) experience. Although universities do emphasize T&L, it might often not even be mentioned during interviews. In the field of education lecturers are more aware of using tools such as Bloom's Taxonomy during their T&L activities. However, in the field of information systems limited academic papers are available on how lecturers can align their goals with the assessment in their courses. In this paper Bloom's Taxonomy Table was used to evaluate the alignment of goals of the case and the assessment done on a fourth-year level subject offered in the information systems field. The purpose of the paper was firstly to reflect on the practice of using Bloom's Taxonomy Table as an evaluation tool and then secondly to provide a set of guidelines for lecturers who want to use Bloom's Taxonomy Table in alignment studies.

Keywords: Bloom's Taxonomy, Bloom's Taxonomy Table, Evaluation of assessment.

1 Introduction

"Publish or perish" – a phrase already coined by Coolidge in 1932 [3], is often heard these days when one visits a university where grant funding, h-factors and publication avenues are the focus of discussions. Staff at universities are experiencing pressure to publish more in reputable outlets to support the universities to raise in the rankings. This is a world-wide phenomenon discussed at some of the top conferences in the information systems field, and, my colleagues assure me, also other fields.

Although we do not negate the importance of research, we do observe staff being under immense pressure in terms of publication, to the extent where it then sometimes results in negligence of their teaching activities. "Good teaching" is accepted as a given and often not even mentioned in appointment committees, but teaching is actually an art and the lecturer needs all the tools at their disposal to also be successful in the classroom. Good teaching practices are found in an overwhelming number of publications and many courses exist for the novice lecturer. One of the tools used in education to guide lecturers is Blooms Taxonomy, developed in 1956 by Benjamin Bloom as a

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Proceedings of the 47th Annual Conference of the Southern African Computer Lectures' Association (SACLA 2018)
ISBN 978-0-720-80192-8

framework for categorizing educational goals – the Taxonomy of Educational Objectives [2].

Bloom's Taxonomy [2] defined six major categories in the cognitive domain. The categories were *knowledge*, *comprehension*, *application*, *analysis*, *synthesis*, and *evaluation*. The framework was revised 45 years later by Anderson et al [1], who added another dimension to the taxonomy after realizing that a category such as *knowledge* embodies both noun and verb aspects. The new taxonomy allowed for the noun and the verb to form separate dimensions, "the noun providing the basis for the Knowledge dimension and the verb forming the basis for the Cognitive Process dimension" [5, p.213]. The knowledge dimension consists of *factual knowledge*, *conceptual knowledge*, *procedural knowledge* and *metacognitive knowledge*.

Our research interest was in investigating whether the Bloom's Taxonomy Table could be used as evaluation tool to get an indication of the alignment between outcomes defined for an information postgraduate course and the assessment used for the course. After conducting a case study, our contribution in this paper is a set of guidelines that course coordinators can use to support them during alignment of goals and assessment.

In this paper we provide background on Bloom's Taxonomy in section 2, followed by the method followed in section 3, as well as how we used Bloom's Taxonomy Table as evaluation tool. In section 4 we provide the alignment data, followed by a discussion on the value of using Bloom's Taxonomy Table in section 5. In section 6 we offer a proposed set of guidelines. The conclusion is provided in section 7.

2 Background

2.1 Bloom's Revised Taxonomy

The goal of the founders of Bloom's Taxonomy was to develop a "method of classification for thinking behaviors" and consisted of the cognitive, affective and psychomotor domain. Bloom's Taxonomy focused on the cognitive domain and was published in 1956 [4], with several levels of thinking and six levels of complexity. The levels were often seen as a ladder, where the learner moved through the different levels to acquire a higher level of cognition. The first three levels were knowledge, comprehension and application, followed by the higher levels of cognition, namely analysis, synthesis and evaluation (Figure 1) [4]. In the revised taxonomy the *cognitive process* dimension was changed to *remember*, *understand*, *apply*, *analyze*, *evaluate* and *create* (Figure 1).

In Table 1 we summarized the cognitive process dimension where the first level, *remember*, focuses on recall and the type of questions the instructor will ask himself is: 'Can the student recall or remember the information?' [7]. On the second level, *understanding*, the question of importance to ask is, 'Can the student explain ideas or concepts?' For *applying* the question is, 'Can the student use the information in a new way?' while for *analyzing* the instructor asks if the student can distinguish between the different parts. On the fifth level, *evaluating*, the instructor asks the question, 'Can the student justify a stand or decision?' while regarding creating the question the instructor asks is whether a student can create a new product or point of view [7].

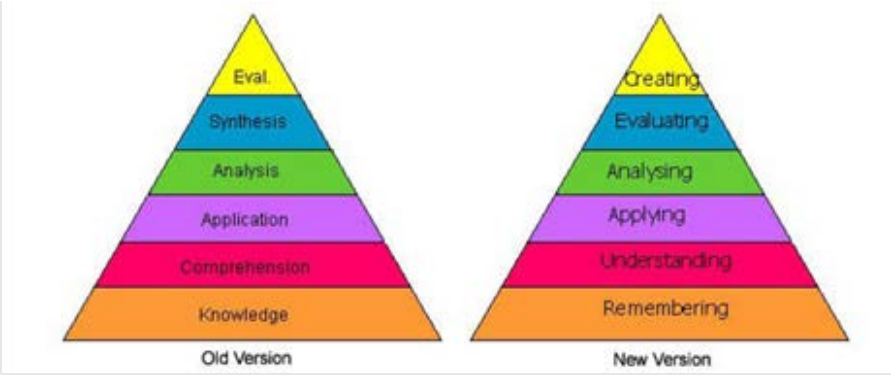

Fig. 1. Original and revised Bloom's taxonomy.

Table 1. Cognitive process dimension of the revised taxonomy [5].

Cognitive Process Dimension	Consists of
1. Remember – Retrieving relevant knowledge from long-term memory.	1.1 Recognizing 1.2 Recalling
2. Understand – Determining the meaning of instructional messages, including oral, written, and graphic communication.	2.1 Interpreting, 2.2 Exemplifying, 2.3 Classifying, 2.4 Summarizing, 2.5 Inferring, 2.6 Comparing, 2.7 Explaining
3. Apply – Carrying out or using a procedure in a given situation.	3.1 Executing 3.2 Implementing
4. Analyze – Breaking material into its constituent parts and detecting how the parts relate to one another and to an overall structure or purpose.	4.1 Differentiating 4.2 Organizing 4.3 Attributing
5. Evaluate – Making judgments based on criteria and standards.	5.1 Checking 5.2 Critiquing
6. Create – Putting elements together to form a novel, coherent whole or make an original product.	6.1 Generating 6.2 Planning 6.3 Producing

As mentioned, the revised taxonomy consists of two dimensions. The first is the cognitive process dimension where, the focus is on the process used to learn. The second dimension is the knowledge dimension (or the kind of knowledge to be learned). The knowledge dimension consists of *factual knowledge*, *conceptual knowledge*, *procedural knowledge* and *metacognitive knowledge.* As described by Anderson [1], *Factual Knowledge* "refers to the basic elements that students must know to be acquainted with

a discipline or solve problems in it." Knowledge of terminology and of specific details and elements is important. *Conceptual knowledge* "refers to the inter-relationships among the basic elements within a larger structure that enable them to function together" [1]. The focus is on knowledge of classifications, categories, principles, generalizations, theories, models and structures. *Procedural knowledge* relates to "How to do something; methods of inquiry, and criteria for using skills, algorithms, techniques, and methods" [1]. For procedural knowledge, the knowledge of subject-specific skills, algorithms, techniques, methods and knowledge of criteria for determining when to use appropriate procedures are significant. Lastly, *metacognitive knowledge* focuses on the self and cognition in general where strategic knowledge and knowledge about cognitive tasks plays a role.

2.2 Objectives and Assessment

In education it is imperative that the lecturer aligns the objectives defined for the course with the different assessments. Alignment, according to La Marca et al. [6], refers to 'bring[ing] into a straight line; to bring parts or components into proper coordination or … into agreement'. Webb [8] states that in education alignment refers to how the elements in a system work together in order to create a learning environment that guides instruction and student learning. It is possible to improve the efficiency and effectiveness of the education system by aligning the goals and assessments for a course [6]. It is possible to work more effectively and set priorities if the assessment is aligned with the objectives of the course.

La Marca et al. [6] provided six guidelines that can be seen as the foundations of an aligned system of standards and assessment. Below we adapted the guidelines to be specific for higher education:

1. Improvement of student performance;
2. Classroom instructional practices be based on a curriculum;
3. Alignment of educational practices and philosophies and educational agencies;
4. Where applicable, visible and unguarded external assessments;
5. Periodic and continuous process evaluated regularly; and
6. Valid decision-making based on data, depending on the degree of alignment between objectives and assessments.

The research discussed in this paper assists with guideline no. 6 above, namely ensuring that objectives and assessment align.

3 Research Design

For this research we followed an interpretive approach and used a case study. The case was a postgraduate course where the purpose was to investigate if the use of the Bloom's Taxonomy Table could support the lecturers to establish how the goals of the study aligned with the assessment used at the end of the course. Bloom's Taxonomy Table (discussed in section 3.1) was used as guideline to evaluate the alignment of goals

and assessment after the course ended in 2017. For the alignment exercise an iterative approach was taken – we first established the goals and then aligned them with the assessments done. During the process, guidelines were identified as presented later in the paper.

In section 3.1 we provide the user with the Bloom's Taxonomy Table used during the research to map both the goals and the assessment. In section 3.2 an overview is provided on the postgraduate module used as the case study.

3.1 The Bloom's Taxonomy Table

The Bloom's Taxonomy Table uses both the *cognitive process* and *knowledge dimension* in a two-dimensional table to map elements of a course. For example, if we want to map the goal, "Objective 1: Remember the different enterprise architecture frameworks", the first part, *remember*, uses a cognitive process and the second, *different enterprise architecture frameworks*, is then a sub-category of factual knowledge (Table 2) and is therefore mapped in A1.

Table 2. Cognitive process dimension of the revised taxonomy [5].

	Cognitive Process Dimension					
The Knowledge Dimension	**1 Remember**	**2 Understand**	**3 Apply**	**4 Analyze**	**5 Evaluate**	**6 Create**
A. Factual Knowledge	Objective 1					
B. Conceptual Knowledge						
C. Procedural Knowledge						
D. Metacognitive Knowledge						

3.2 The Case Study Module

The advisory board of the department argued that there was a need for training students in disruptive technologies at postgraduate level, and it was decided to include a capita selecta module on disruptive technologies. The module carries a weighting of 15 credits, indicating that on average a student should spend around 150 hours to master the required skills (including time to prepare for tests and examinations). Eight contact sessions of 1.5 hours each were scheduled during the semester and because of the limited duration of contact sessions, a blended learning approach was adopted, where students had to submit preparation assignments before class on the material to be presented during the session. The preparation assignments were open-book automated assessments that mainly tested understanding. Preparation beforehand allowed for discussion opportunities during class, thus focusing on application, analysis and evaluation (the higher cognitive processes).

Since no applicable handbook on disruptive technologies could be found, we compiled the course from selected publications and books, as well as online content. A

selected reading list was provided, as well as additional content. The module topics we decided to include with associated module objectives are depicted in Table 1.

Table 3. Course syllabus and objectives.

Topic	Objective and description
1)Fundamentals, concepts and definitions	Objective 1: Understand what disruptive technologies are, as well as what is meant with terms such as *disruptive innovation, digital disruption, digital transformation and disruption revolution.*
	In this section a summary of the literature on disruptive technologies, as well as the associated terms and how these terms are related, was presented and discussed.
2)Technological landscape for disruptive technologies	Objective 2: Understand the technological landscape and the unique characteristics of modern technological developments that support and underpin disruption.
	In this section technological development as well as the various perspectives on what makes a technology disruptive were presented and discussed. Students were expected to be able to classify a technology (or compare technologies), given the perspectives.
3)Disruptive business models	Objective 3: Understand the characteristics of business models that are typically threatened by disruptions or that are able to harness the advantages of disruptive technologies.
	In this section the business models of 'unicorn' companies were explored and contrasted with traditional business models.
4)Theories of Disruption	Objective 4: Understand and be able to apply the relevant theories to evaluate disruption.
	This section focused on the theory of disruptive innovation and how to evaluate a disruptive technology given the theory.
5)Design Thinking	Objective 5: Be able to apply design thinking to disruptive problems for innovation.
	This section of the course introduced the design thinking methodology of Stanford University, given the context of disruptive technologies and business models.

Assessment during the course consisted of formative assessment using four preparation assignments that students had to submit before class, as mentioned. Summative assessment was done through a mid-term semester test assignment on the first three topics, as well as the final examination assessment, which was a 48-hour take-home assignment. The examination assignment consisted of six questions on the whole syllabus, but was somewhat biased towards the last topics, since the first topics had already been assessed. The examination assignment used the context of a case study of universities of the future and the possibilities of disruption of higher education, given technologies such as MOOCs and online learning platforms. The paper followed the design thinking methodology and expected students to apply the knowledge presented in the course, given the future higher education context.

4 Case Study Evaluation

Our first task was to map the objectives of the module to the Bloom Taxonomy Table. The first objective for the module was '*Objective 1: Understand what disruptive technologies are, as well as what is meant with terms such as disruptive innovation, digital disruption, digital transformation and disruption revolution*'. For this objective the student needs to *analyze* and differentiate between concepts. Only *factual knowledge* is needed and it is therefore mapped on the Bloom's Taxonomy Table in cell A4, abbreviated as O1 (Objective 1). Objective 2 (O2) was defined to be 'Understand the technological landscape and the unique characteristics of modern technological developments that support and underpin disruption.' For this objective a student should be able to classify, explain and compare facts, using factual knowledge. O2 is therefore mapped to cell A2.

Similarly, 'Objective 3: Understand the characteristics of business models that are typically threatened by disruptions or that are able to harness the advantages of disruptive technologies', expected students to compare and explain matters using factual knowledge and was therefore also mapped to cell A2. For Objective 4, 'Understand and be able to apply the relevant theories to evaluate disruption', we expected the students to apply the theory in order to evaluate a disruptive technology. The mapping was done in cell B5 where the knowledge domain is conceptual. Lastly, for Objective 5, 'Be able to apply design thinking to disruptive problems for innovation', we expected the student to use the design thinking methodology to create a solution, given the context of disruptive technologies and business models. The knowledge needed for this type of requirement is procedural knowledge, where the methods are playing a role. The focus is on the creation and therefore we plotted the objective in C6.

Table 4. Mapping of the course objectives.

	Cognitive Process Dimension					
The Knowledge Dimension	**1 Remember**	**2 Understand**	**3 Apply**	**4 Analyze**	**5 Evaluate**	**6 Create**
A. Factual Knowledge		O2 O3		O1		
B. Conceptual Knowledge					O4	
C. Procedural Knowledge						O5
D. Metacognitive Knowledge						

In order to link the goals and the assessment with one another, our next step was to map the summative assessment done using Bloom's Taxonomy Table. For the mid-semester assessment students had to complete an assignment and for the final assessment students were given a 48-hour take-home assignment. They could use any resources available to complete the assignments and all submissions were checked for plagiarism using TurnitIn.

In the test assignment students were asked to choose either blockchain or crypto currencies as a disruptive technology. Test question 1 (TQ1) asked students to do a thorough literature review on the chosen technology with proper citations and referencing. TQ2 and TQ3 asked students to do an evaluation of the chosen technology given two distinct methods included in the syllabus. TQ4 asked students to apply the theory of disruptive innovation to the technology.

For the examination assignment students received a case study describing the possibility of disrupted higher education given the characteristics and demands of millennials as well as the unique profile of South African students. The first two questions, Examination Question 1 and Examination Question 2 (indicated as EQ1 and EQ2) requested the student to provide short literature reviews of the higher education institution and the student of the near future. Examination Question 3 (EQ3) requested the student to "Apply the five modes of the Stanford Design Thinking methodology to the scenario described …" and to "summarise each mode with reference to the future of South African higher education and how you would execute each mode". EQ4 requested students to 'Execute the Empathy Mode of the Stanford Design Thinking methodology ...' and to 'develop two composite character profiles'. EQ5 requested the student to use the results of his/her empathy mode and execute the define mode of the Standford Design Thinking methodology by using the point-of-view (POV) Madlib method card to *develop* a POV for disruptive higher education in South Africa. EQ6 asked the student to use the results of his/her empathy and define modes, and then to *execute* the ideate mode of the Stanford Design Thinking methodology. Q6.1 asked the student to identify applicable disruptive technologies and argue why they are disruptive, and for EQ6.2 the student needed to propose solutions to the identified POV of the previous questions. EQ7 expected the student to apply the theory of disruptive innovation and evaluate his proposed solution. The last question, EQ8, requested the student to use the results of his/her executed modes of the Stanford Design Thinking methodology, and design an exponential organization.

In order to map the assessment to Bloom's Taxonomy Table, we first had to map questions to objectives. We immediately realized that for the first questions in both assessments (TQ1, EQ1 and EQ2) we expected students to do literature reviews where we assessed synthesis of the literature and referencing, but we never set a course objective for these skills. The remainder of the questions where mapped by placing the objective before the question, e.g. because TQ2 and TQ3 asked students to evaluate disruptive technologies, they mapped to Objective 2 indicated by O2:TQ2 and O2:TQ3. All the assessment questions were thus mapped to course objectives.

For placement of the questions along the knowledge dimension, we categorized the literature review questions as factual knowledge. The students were required to be able to organize and differentiate maps to analyze cognitive process dimension, and the questions were plotted in cell A4. The placement is shown as TQ1, EQ1 and EQ2 in Bloom's Taxonomy Table (Table 5).

Table 5. Mapping of the assessment questions.

	Cognitive Process Dimension					
The Knowledge Dimension	**1 Remember**	**2 Understand**	**3 Apply**	**4 Analyze**	**5 Evaluate**	**6 Create**
A. Factual Knowledge			O5:EQ4	TQ1, EQ1, EQ2		
B. Conceptual Knowledge			O5:EQ3		O2:TQ2, O2:TQ3, O4:TQ4, O2:EQ6.1, O4:EQ7	O5:EQ5, O5:EQ6.2, O3:EQ8
C. Procedural Knowledge			O5:EQ3			
D. Metacognitive Knowledge						

Regarding the test assignment, all the questions (TQ2, TQ3 and TQ4) required an evaluation given conceptual knowledge of different topics or objectives. For placement on the knowledge dimension we selected cell B5 and indicated the placement with O2:TQ2, O2:TQ3 and O4:TQ4, indicating that TQ2 and TQ3 assessed Objective 2 and TQ4 assessed Objective 4.

Regarding the examination assignment, EQ3 requested the student to "Apply the five modes of the Stanford Design Thinking methodology to the scenario described …", and further to "summarise each mode with reference to the future of South African higher education and how you would execute each mode." For our placement on the knowledge dimension we argued that conceptual knowledge is needed since the interrelationships among basic elements within a larger structure plays a role. For the cognitive process dimension, the student was involved in understanding and applying the work and therefore we place the question (EQ3) in B3 as O5:EQ3 (indicating that we were assessing Objective 5). However, the student was also required to apply procedural knowledge to the case study, which places the question in cell C3 (the application of procedural knowledge).

EQ4 requested students to execute and develop given Design Thinking (Objective 5) and this question was placed in cell A3, since the expectation related 3.1, executing, and 3.2, implementing, as described in Table 1. EQ5 requested the student to use previous results and execute and develop, using a given method card. Regarding this question, creation played a central role, where different concepts from Objective 5 needed to be related in answering the question and therefore we placed it in cell B6 as O5:EQ5. For EQ6.1 the student was expected to use previous results and then to execute, thus looking for relationships between characteristics of disruptive technologies (Objective 2). The question therefore maps towards conceptual knowledge. The student furthermore had to evaluate and therefore the placement was in cell B5 as O2:EQ6.1. For EQ6.2 the student needed to propose solutions to a problem and the question was placed in B6. EQ7 expected the student to apply and evaluate, given the theory of disruptive

innovation (Objective 4) and O4:EQ7 was therefore placed under conceptual knowledge and evaluation in cell B5. The last question, EQ8 requested the student to use previous results and design an exponential organization (Objective 3). We placed the question on B6 as O3:EQ8, since the student was required to link concepts and then to create a solution.

The next step in our alignment of the objectives and assessment was to illustrate on one single table both the objectives and the assessment questions in order to discuss the alignment (Table 6). This table can be used to do an evaluation of the alignment of course objectives and summative assessment. Alignment is present when the objective and assessment appear in the same cell. The results will be discussed in the next section.

Table 6. Alignment of objectives and assessment.

	Cognitive Process Dimension					
The Knowledge Dimension	**1 Remember**	**2 Understand**	**3 Apply**	**4 Analyze**	**5 Evaluate**	**6 Create**
A. Factual Knowledge		**O2**, **O3**	O5:EQ4	**O1**, TQ1, EQ1, EQ2		
B. Conceptual Knowledge			O5:EQ3		**O4** O4:TQ4, O4:EQ7	O5:EQ5, O5:EQ6.2
					O2:TQ2, O2:TQ3, O2:EQ6.1	O3:EQ8
C. Procedural Knowledge			O5:EQ3			**O5**
D. Metacognitive Knowledge						

5 Discussion

According to Anderson et al. [1], it is possible to determine one's degree of alignment by correlating one's objectives, instruction and assessment. In our case we used Bloom's Taxonomy Table similar to some examples provided by Anderson et al. [1] to determine how the objectives and assessment questions align (Table 6). Given the case study and mapping of objectives to assessment, we detected some alignment, as well as substantial misalignment, as will be indicated in the list below. We also include remediating actions in the list.

- TQ1, EQ1 and EQ2 asked students to complete a literature review, but the ability to do such a review was never formulated as an objective. Since this is a postgraduate course, students will be exposed to literature reviews; however, if the ability is assessed, it should be a course objective and such a course objective was added for 2018;

- Similarly, Objective 1 (O1) was placed in A4 but never assessed during summative assessment. We realized, however, that O1 was assessed during the preparation assignments, but summative assessment of this objective should ideally also be included in 2018.
- Objectives 2 and 3 (O2, O3) were placed in cell A2; however, these were assessed in cells B5 and B6, which indicates substantial misalignment. The objective only stated that the factual knowledge of the content should be understood. However, during assessment we expected students to be able to evaluate and create using conceptual knowledge of the content. After consideration of what we wanted to achieve with this course at postgraduate level, we decided to reformulate the objectives for 2018 judiciously to ensure placement in cell B5 at least – a movement of a row on the knowledge dimension and 3 columns on the cognitive process dimension. We also decided that the assessment criteria should be carefully reconsidered with regard to the 'create cognitive dimension' since possibly only evaluation is necessary for a course at Honors level.
- Objective 4 (O4) was assessed correctly, possibly because the topic concerned the application of theory and it was assessed as such in both assessments.
- Objective 5 (O5) was mapped as C6 but assessed in A3, B3, C3 and B6. We therefore originally expected the student to be able to create or produce new procedural knowledge, but we only assessed creation on the conceptual level (B6). The A3, B3 and C3 assessment is not problematic, as it assesses building blocks of Objective 5. We scrutinized the reasons for the misalignment of O5 and its assessment, and realized that it is a challenge to assess the creation of procedural knowledge with written assignments. Assignments are more suitable for the assessment of conceptual knowledge, hence the B6 mapping. Procedural knowledge could be assessed, for example, using a practical implementation.

6 Guidelines for Using Bloom's Taxonomy Table to Align Objectives and Assessment

As mentioned in section 3, we used an iterative post-module presentation approach to align the objectives with the assessment. As evaluation tool this worked perfectly well, but if one wants to use the table as guiding tool, it is imperative that the tool should be used at the beginning of the course when the objectives are set. During the evaluation process we made notes on practices used took part in a discussion session where these notes were formalized into guidelines. For novice users of Bloom's Taxonomy Table, we advise the following:

- Always use Bloom's Taxonomy Table at the beginning of the course to identify objectives that fit the level of learning required on the cognitive process dimension for the course (for example in South Africa NQF levels are used to indicate the level of learning).

- Bloom's Taxonomy Table assumes that the columns further to the right in cognitive process dimension include the preceding processes in columns to the left. Assessment questions need to be mapped to the appropriate cognitive process dimensions, but in the beginning of the course it might be appropriate to assess lower levels of cognitive process dimensions, as long as the final assessment aligns with the dimension set by the course objectives.
- If misalignment occurs on the cognitive process dimension, the implications are that lower assessment levels benefit students, however the lower assessment levels affects the quality of the course since objectives are not appropriately assessed.
- All knowledge dimensions included in the objectives need to be assessed during the course.
- The semantics of terms used in objectives and assessment, e.g. understand, apply and evaluate need to be used appropriately. Careful wording with descriptions should be used so that misunderstandings and misalignment are prevented.

7 Conclusion

Education is one of the oldest fields in research and one of our core responsibilities at higher education institutions is to be involved in teaching and learning. Staff teaching information systems often teach without prior training in education practices and find the available tools overwhelming. In this paper we firstly provided a synopsis of how Bloom's Taxonomy Table can help the information systems lecturer to offer a course at the right level and then to evaluate how the goals align with the assessment. The value of the case study is that we often understand better when we see examples related to our own field of study. Secondly, we provided a set of guidelines to be used by lecturers interested in using the Bloom's Taxonomy Table as alignment tool. As lecturers we found the tool valuable and it gave us insight into how we should reconsider our goals set for the course. It also showed us the value of using the right semantics during your goal setting and assessment in order to ensure alignment. We will recommend its use as an evaluation tool, but mostly as a planning tool during goal setting and alignment of assessments.

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