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Maximizing Learning Through Course Alignment and Experience with Different Types of Knowledge

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Abstract Consistency among the objectives, learning activities, and assessment exercises results in aligned courses, which give students direction and clarity and yield increased learning. However, instructors may not check for course alignment. This article describes a concrete way to determine course alignment by plotting the course components on a table using the cognitive process levels from a revised taxonomy of learning objectives. Once instructors realize that courses are misaligned, they can make adjustments. By giving students experience with varied types of knowledge, which is the other part of this taxonomy, they also learn more. The types of knowledge include factual, conceptual, procedural, and meta-cognitive knowledge.

Key words course alignment · student learning · objectives

We know through our experiences that how instructors plan and teach their courses influences what students learn. An essential aspect of course planning is the development of appropriate objectives or learning outcomes. The objectives for a course should be consistent with the delivery of the content and with the way the instructors assess the students. Educators call this best practice, which increases student learning, course alignment (Biggs 1999), or integrated course design (Fink 2003). This article introduces a simple way to determine if courses are aligned or integrated so as to encourage consideration of the levels of cognitive processes required in the objectives, in the teaching and learning methods, and in the assessment of learning.

Another way instructors maximize student learning is by giving students opportunities to use and apply the content with different types of knowledge. This article offers explanation

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of these two ways—course alignment and using the content with different types of knowledge—to maximize student learning through the use of Anderson's et al. (2001) revised taxonomy of learning objectives. This revised taxonomy uses levels of cognitive processes to define the verbs used in objectives and the different types of knowledge required to meet the objectives.

Taxonomies for Objectives

For about a half century, educators wrote objectives using Bloom's (Bloom et al. 1956) taxonomy, which identified a hierarchy of the levels of learning from recall to evaluate. While many educators have used this taxonomy, it nonetheless has disadvantages. It does not take into consideration the types of learning or knowledge, and it reflects the behaviorist psychological theories that were accepted in the mid-twentieth century; nonetheless, to a lesser extent this taxonomy still continues to be used. As such, it is not congruent with current, cognitive psychological theories that postulate how learning can occur. Fortunately, some of the original authors of Bloom's taxonomy along with other educators and psychologists revised this taxonomy at the beginning of this century (Anderson et al. 2001). This revision is more consistent with current theories of psychology and learning as it considers the type of cognitive processes occurring in learning and the types of knowledge required. While this revised taxonomy offers advantages over Bloom's original taxonomy, it is still not widely used in higher education for the planning of courses or curricula.

Anderson et al. (2001) Revised Taxonomy

The new taxonomy is a two-dimensional table, which illustrates the level of cognitive processes or verbs along one axis and the types of knowledge along the other axis. The levels of cognitive processing are similar to Bloom's original taxonomy, but the types of knowledge are a new concept. The six levels of cognitive processes form a hierarchy and range from (a) remember, (b) understand, (c) apply, (d) analyze, (e) evaluate, to (f) create. This revised taxonomy lists additional verbs within each of the six levels. For example, the rather immeasurable verb at level 2, "understand", includes measurable verbs like interpret (data), exemplify, classify, summarize, compare, and explain. "Analyze" is further defined by the verbs differentiate, organize, and attribute.

According to this taxonomy, there are four different types of knowledge: (a) factual, (b) conceptual, (c) procedural, and (d) meta-cognitive. Unlike the levels of cognitive processing, these four types of knowledge are not a hierarchy. Factual knowledge is knowledge of terminology such as technical vocabulary and facts as well as basic elements such as knowledge of people, events, locations, or dates (Anderson et al. 2001). While factual knowledge may be inert or surface level knowledge (Biggs 1999), it is the foundation upon which all other types of knowledge are built. The educators who articulated this taxonomy emphasized the necessity of instructors helping students to use factual knowledge in constructing or enhancing their conceptual and procedural knowledge.

Conceptual knowledge is knowledge of classifications and categories, principles, generalizations, theories, models, and structures. It is more complex, and more organized than factual knowledge and reflects deep understanding of content (Biggs 1999). This is "the what of knowledge." The scholars who developed this taxonomy purposely distinguished factual knowledge from conceptual knowledge as a way of focusing on the need to emphasize how knowledge fits into larger systematic perspectives. If instructors only encourage students to remember isolated facts, they are promoting only the acquisition of factual knowledge. Conceptual knowledge is the preferred type of knowledge because it leads to better retention and the ability to use the knowledge.

Procedural knowledge is discipline-specific knowledge of skills, algorithms, techniques, or methods. It also includes knowledge of the criteria used to determine when to use various procedures. This is "the how of knowledge." Procedural knowledge often involves a series of logical steps (Anderson et. al. 2001).

Meta-cognitive knowledge is the knowledge of general strategies for learning and thinking; and thus sometimes it is referred to as strategic knowledge, knowledge about cognitive tasks including contextual (when and how to use cognitive strategies or tasks) and conditional knowledge (when and why to use strategies appropriately). Meta-cognitive knowledge also includes knowledge of one's own strengths and weaknesses in relation to cognition and learning, which is self-knowledge. This type of knowledge involves thinking in general and an awareness of one's own thinking processes. Meta-cognitive knowledge often involves becoming aware of individual differences and perspectives, which then leads one to realize that there may not be only one correct answer to a problem, thus having implications for assessment (Anderson et al. 2001). Anderson et al. (2001) included meta-cognitive knowledge in their taxonomy because research has shown that the understanding of one's own cognition influences how much learning occurs (Bransford et al. 2000). This fourth type of knowledge is also consistent with current thinking on learner-centered teaching because encouraging students to develop their strategic knowledge or self-knowledge fosters greater learning (Weimer 2002). The inclusion of meta-cognitive knowledge is a compelling reason why I think using this revised taxonomy of objectives may help to maximize learning.

In this article I use both the concepts of cognitive processes and the types of knowledge to suggest ways to maximize learning. However, I suggest using them separately and differently. I propose using the cognitive process levels to assess the consistency among the objectives, the teaching and learning approaches, and the assessment methods. In addition, I suggest that instructors promote the acquisition of varied types of knowledge to enhance the students' ability to learn the content of the course. When instructors intentionally expand opportunities for students to encounter the four types of knowledge, students should learn more. Moreover, all of these concepts can be further extended to designing a curriculum.

Importance of Objectives to Maximizing Student Learning

As instructors design courses they should consider the three key aspects of any course, which are the objectives, the teaching and learning activities, and the assessment exercises. The objectives list the desired learning outcomes at the end of the course. Instructors should state them in terms of student performance or what students should be able to do after the course. The teaching activities are what the teacher does with the students. The learning activities are what the students do in the course. These learning activities occur both in class and out of class; they may be teacher-directed or more self-directed. Assessment activities then determine if the students have met the objectives or learning outcomes. The same concepts apply equally well to the design of curriculum.

Because objectives express what instructors want students to have learned after the completion of the course, they should direct the planning and delivery of courses. Objectives also serve as the starting point for instructors to consider how student learning should occur. Therefore, when used properly, objectives drive the student learning. Clear statements of objectives help the instructor plan the course in terms of the content to be covered, the teaching and learning activities within the course, and the assessment methods. Quality education requires an overall structure that ensures that all students have sufficient opportunities to attain the objectives of the course through their learning activities and that they can demonstrate that they have met these objectives through various assessment exercises. Student assessment should flow directly from the instructor's statement of instructional goals or objectives. Clearly stated performance-based goals and objectives facilitate fairness in both testing and grading and are good elements of course design.

Well-stated objectives can improve communication between instructors and students. They can make student learning more efficient and reduce student anxiety because they know what the instructor expects of them and what their learning priorities should be. Consistency and alignment of the course objectives, content delivery and learning activities, and the assessment methods help students understand why they are taking this course and help them see how this course relates to other courses and to the overall program goals (Biggs 1999). Therefore, objectives should serve a critical, integrating role in courses and curricula both for instructors and for students.

Course Alignment Increases Student Learning

As mentioned above, alignment requires consistency among all of the core parts of the course, that is, the objectives, the teaching and learning activities, and the assessment exercises. (Biggs 1999). When they are consistent, they support each other (Fink 2003). Aligned courses lead to maximum student learning, and there is a greater chance that the students will achieve the goals and objectives for the course. Instructors can align courses at any of the cognitive process levels. Alignment does not convey a value judgment about the appropriateness for the level of the course for college students or about the quality of the educational experience for the students. Instructors can make this determination after looking at the alignment.

If courses are misaligned, it is probably because instructors are using differing cognitive process levels in their objectives, teaching and learning activities, and assessment exercises. Often the objective requires a higher level of cognitive processing than do the teaching and learning activities and the assessment exercises. For example, instructors have misaligned courses when there are lofty goals stated for a course; but the assessment exercises only require recall of information.

Method to Determine Course Alignment

In planning courses, instructors may not take the abstract concept of alignment into consideration. Therefore, it is likely that courses could be misaligned. Sometimes making abstract concepts more concrete through the use of a graphic representation helps to illustrate the point. I have developed a simple method to explore course alignment graphically. Every major course objective should have at least one teaching and learning activity and at least one assessment method that correspond to that objective. Instructors can determine the cognitive process level required for the students with their objectives, teaching and learning activities, and assessment exercises. Then the instructors plot the relationship among these cognitive levels for each objective, its related teaching and learning activities, and assessment exercises using the following method of listing them and then comparing them. In the process of plotting these elements, instructors should not consider the types of knowledge required, only the cognitive process or verbs that the students need to use.

Part 1. Listing the Objectives, Teaching and Learning Methods, and Assessment Exercises Table I provides a graphic tool to determine if a course is aligned. Instructors should use a separate table for each major course objective or learning outcome.

The instructor completes Table I by following these steps:

1. Briefly list one course objective in the correct cell or cells according to the verbs listed in the cognitive process dimension along the objectives row. These objectives should be stated as student learning outcomes. Therefore, the student action will determine the correct placement.
2. Briefly list the teaching and learning activities in that row in the correct cell or cells according to the verbs listed in the cognitive process dimension. The decision about correct placement in the cells is made by determining what level of cognitive process the students need to use during the teaching and learning activities.
3. Briefly list the cognitive process required for the related assessment exercise(s), such as tests or graded assignments, along the assessment row in the correct cell or cells according to the verbs listed in the cognitive process dimension. Instructors should again determine the cognitive process level required of the students in order to complete the assessment task. The cognitive process level required of students in many multiple choice items is recall or understand.
4. If an objective does not have a corresponding teaching and learning activity or an assessment exercise, indicate that this aspect is not included in the course by checking the second column on the table on the appropriate row for the missing teaching and learning activity or assessment exercise. When a course does not have at least one teaching and learning activity and also at least one exercise for each objective, the course is misaligned.

Part 2. Determining if a Course/Curriculum is Aligned For each set of objectives, teaching and learning activity (activities) and assessment exercise(s), draw a line or lines connecting the cells marked in these three columns.

- A straight, vertical line connecting all rows means this is aligned course.
- One or more diagonal lines, without a corresponding vertical line connecting the objective, illustrates that the course is misaligned.

It can be appropriate to have teaching and learning activities at a lower level than the level of the objective to prepare the students to do the higher cognitive level work. However, these activities also need then to include work that is at the same cognitive level as the objective. The same is true for assessment exercises. Instructors will want to include some assessment exercises that are at lower cognitive levels, but the majority of the assessment tasks should be at the same cognitive level as the objective.

Once an instructor has plotted the alignment of the objectives, teaching and learning activities, and assessment exercises, it is easy to recognize misalignment, which should lead to instructors rethinking aspects of their courses or course revision. To align a course, instructors can alter the objectives, the teaching and learning activities, or the assessment exercises so as to be consistent. For example, an instructor might increase the cognitive

Table I Course Alignment Table

		The Cognitive Process Dimension (according to Anderson et. al. 2001)					
What level is each of the following?	Aspect is not included in the course	1. Remember (recognize, recall)	2. Understand (interpret, exemplify, classify, summarize, infer, compare, explain)	3. Apply (execute, implement)	4. Analyze (differentiate, organize, attribute)	5. Evaluate (check, critique)	6. Create (generate, plan, produce)
Objective							
Teaching /learning methods							
Assessment task requirements							

Use a separate table for each major course objective. (Table I is modified from Blumberg 2009.)

processes required in the assessment exercises in order to be more consistent with higher cognitive process level objectives.

Acquisition of Different Types of Knowledge to Maximize Learning

While instructors want a course to be aligned or consistent in the levels of cognitive processes or verbs used in the objectives, the teaching and learning activities, and the assessment exercises, instructors should try to promote mastery by having the students engage with content in varied contexts. These different contexts relate to different types of knowledge. As Anderson et al. (2001) defined the four types of knowledge—factual, conceptual, procedural and meta-cognitive, they are qualitatively different; but all are important for mastery of any discipline. The types of knowledge do not form a hierarchy in importance; nor to they reflect the cognitive processes required or the concept of course alignment.

This section shows how instructors should plan for students to use content in a variety of ways to maximize learning. Thus, it focuses on the teaching and learning activities. By being systematic and seeking to enhance the students' acquisition of knowledge in all four areas, instructors will help students develop a better mastery of the content of the course and retain their learning better. Instructors might even check to see that the students have opportunities to use content that employs as many types of knowledge as possible. Not all the content in courses may require procedural knowledge; but it should require factual, conceptual, and meta-cognitive knowledge. Curricula, on the other hand, should have all four types of knowledge embedded in them. Many instructors do not provide enough opportunities for students to employ their meta-cognitive knowledge about the discipline. Through the deliberate inclusion of objectives and teaching and learning activities requiring students to engage with content by the application of meta-cognitive knowledge, instructors encourage the students to reflect on their own learning and thinking processes. As students gain experience with the four types of knowledge, they should increase their ability to remember and apply the content and improve their critical thinking skills. Assessment exercises that involve the different types of knowledge can also identify specific aspects that the students have not yet mastered.

For example, in a quantitative research methods course in the social sciences, the objective might be, "the student will be able to design an appropriate research project to investigate the effectiveness of an intervention." Students will maximize their learning through the use and application of all four types of knowledge. The factual knowledge in such a course involves understanding the definitions of phrases used in quantitative research such as "independent and dependent variables," "null hypothesis," and "tests of significance." These phrases form the foundation of quantitative research. The students need to understand the concept of what constitutes sufficient evidence to reject the null hypothesis, usually done in conjunction with statistical tests; and they need to understand that research offers support of a theory but that a theory is never proved. These concepts involve knowledge of principles and theories or conceptual knowledge. Students need to know which statistical tests would be appropriate for the data that could be collected. This knowledge is procedural knowledge because it involves knowledge of subject-specific techniques and methods. Knowledge of these statistical tests includes the assumptions that must be met to use them, referred to as a subset of procedural knowledge called knowledge of criteria for determining when to use appropriate procedures (Anderson et al. 2001). Students may be overwhelmed with the complexity of the objective, but requiring them to reflect on their learning process or meta-cognitive knowledge might help them to be less overwhelmed. If the instructor asks the students meta-cognitive knowledge questions throughout the course, the students think about their learning and are able to assess how much progress they are making toward achieving the learning outcome for the course. For example, the instructor might ask the students to develop questions or a list of quantitative research concepts that they do not understand as they read the textbook. When students raise these questions in class or on an online discussion board, the instructor knows what concepts need to be further clarified. Knowledge of strategies is also part of meta-cognitive knowledge. Appropriate strategies might involve asking the students to develop a timeline for a research project and a flow diagram to capture all the steps. The students can self-assess if they have identified all of the necessary steps or if they developed a logical plan for the research project.

In this example of a quantitative research methods course, factual knowledge could be assessed through multiple-choice questions or in an online quiz. Conceptual knowledge could be assessed with multiple-choice, short answer, or essay questions. Students could be assessed for procedural knowledge by giving them data sets and asking them to determine which statistical test would be appropriate and why. They might also have to conduct and interpret these tests with these data sets. To assess meta-cognitive knowledge, the students might keep a journal describing what they are learning and what they find confusing about quantitative research methods. The students might develop a checklist of issues to consider as they design an appropriate study. They might include resources to use for each step. The last two examples are further ways to assess meta-cognitive knowledge.

Discussion

The following discussion of a hypothetical physical therapy course should help readers and instructors understand how to determine if a course is aligned and how to assist students to acquire content that employs varied types of knowledge. Use of both of these methods should lead to the maximization of learning. Let us suppose an objective of this hypothetical physical therapy course is, "Evaluate a person who has one or more pulmonary pathologies or cardiovascular pathologies, and develop both a diagnosis and prognosis." Such an objective would require the fifth cognitive processing level, "evaluate", because the students need to make judgments about the patient based on criteria and physical therapy practice standards. This objective also involves the sixth cognitive process level, "create", because the students need to integrate all these elements together in order to generate a diagnosis and a prognosis. This objective requires factual knowledge of pulmonary and cardiovascular pathologies. It involves conceptual knowledge because the students need to know classifications and categories of pathologies in order to be able to develop a prognosis. It involves procedural knowledge in knowing which diagnostic tests or methods should be used. Further procedural knowledge involves the criteria for determining when to use appropriate procedures and how to interpret them.

Let us now suppose that the instructor delivered the hypothetical course as follows. The teaching activities include lectures on pulmonary and cardiovascular pathologies and their associated prognoses and also lectures and demonstrations on the tests physical therapists use to determine these pathologies and ways to interpret them. The resulting learning activity for the students would be to recall and understand the content covered in these lectures. The student activity would require the first and second cognitive processing levels. Finally the students would have a laboratory class where they practice how to perform these tests and practice interpreting the results. These laboratory activities would require the second and third levels of cognitive processing. The assessment exercise is a multiple-choice test asking questions about the pathologies, when and how the tests should be used, and interpretation of test results such as printouts without patient scenarios given. The cognitive level required for the students on the test would be the second cognitive level or "understand." Depending on how the questions were developed, it is possible that they might require the third and fourth cognitive levels. However, none of the assessment tasks would require the same cognitive levels, that of evaluate and create, as the objectives. The students do not have to evaluate patients and independently determine their diagnosis and prognosis. This is a misaligned course because the cognitive process level is not the same for the objectives, the teaching and learning activities, and the assessment exercises. However, instructors may not realize that the course is misaligned until they consider its alignment. Representing this alignment on a table, such as given in Table II, clearly shows that it is misaligned because none of the teaching and learning activities or assessment exercises is at the same cognitive levels as the objective.

To align the course, the instructor needs to make the learning activities and the assessment exercises consistent with the stated objective. An example of an appropriate learning activity would be for the students to practice evaluating people with these pathologies and to develop both diagnoses and prognoses. This would be an appropriate laboratory exercise or could be done as homework with simulations. During the assessment exercises the students should demonstrate their ability to evaluate other people and to develop both an appropriate diagnoses and prognoses.

Further, as previously explained, this physical therapy objective requires both factual, conceptual (the "how of knowledge") and procedural knowledge (the "what of knowledge") (Anderson et al. 2001). The instructor should plan classes, out-of class assignments, and laboratory exercises that allow the students to use all three of these types of knowledge. The way the hypothetical course is described, it probably does not emphasize conceptual knowledge enough. Further the students may go through the steps of interpreting the physical therapy tests, but they may not focus on procedural knowledge so that they would be able to do it on their own. By paying attention to the types of knowledge that are required in an objective, the instructor can focus on teaching and learning activities that help the students to acquire the factual, conceptual, and procedural knowledge required. The assessment exercises should also require the students to use factual, conceptual, and procedural knowledge. Prior to the examinations instructors can emphasize to students that they will be required to use these types of knowledge, which may help them to study differently and not just concentrate on learning the facts in an isolated way. The instructor might even label questions on examinations as requiring factual, conceptual, or procedural knowledge so as to alert the students to what type of knowledge they are required to use on a question.

While not directly implied in the objective, students should also engage the content through meta-cognitive knowledge. They may have a hard time deciding which physical therapy assessment tools, among the many available, to use with a patient. Asking students to construct a strategy or heuristic for deciding which test to use with what group of symptoms is an example of a learning activity involving meta-cognitive knowledge. If the students are required to write their justifications for their heuristic, it can be graded. Students can keep a journal of their learning that records their questions, which may reflect a lack of understanding of the other types of knowledge. These questions can then become the springboard for more learning with clarification by the instructor. Further, the instructor might ask the students to assess how confident they are in their abilities to evaluate patients

Table II Course Alignment for the Physical Therapy Course Described in the Discussion

		The Cognitive Process Dimension (Anderson, et al. 2001)					
What level is each of the following?	Aspect is not part of the course	1. remember (recognize, recall)	2. understand (interpret, exemplify, classify, summarize, infer, compare, explain)	3. apply (execute, implement)	4. analyze (differentiate, organize, attribute)	5. Evaluate (check, critique)	6. Create (generate, plan, produce)
Objective						Evaluate person who has ≥1 pathologies	Develop both diagnosis and prognosis
Teaching/ learning methods		Lecture on pathologies. Lecture on tests to perform to determine these pathologies, how to interpret them.	Lab practice interpreting results	Lab practicing the tests	Lab practice analyzing results		
Assessment task require-ments		Multiple choice tests asking questions about the pathologies, when and how the tests should be used	Multiple choice tests asking interpretation of test results	Some questions could include application	Some questions could ask for analysis		

and to form a diagnosis. When students state that they lack confidence in their abilities, they might be given additional practice exercises. It also serves as an assessment exercise when instructors give students feedback on the accuracy of their confidence or on their insights into their heuristics for decisions.

While some instructors may know how to align their courses or expand the opportunities to employ different types of knowledge that the students experience, others may not. Staff members who work in Teaching and Learning Centers or Centers of Teaching Excellence can assist these instructors who need implementation ideas. The literature on effective teaching or the implementation of active learning techniques can also be helpful. Fink (2003) explained how to design aligned courses and offered many practical suggestions. Discipline-specific educational journals, such as the *Journal of Engineering Education*, *Life Sciences Education*, *Teaching of Psychology*, or the *Journal of Management Education* often contain articles that suggest effective ways to teach procedural or conceptual knowledge in that discipline. Moon (2006) offered many suggestions for teaching and learning activities and assessment exercises that assist students to acquire and improve their meta-cognitive knowledge. Instructors can also benefit from discussion with colleagues.

Conclusion

The intent of this article is to demonstrate how instructors can maximize student learning by viewing objectives as the unifying and driving force for planning teaching and learning activities and assessment exercises. When these activities and exercises relate to and follow from the course goals and objectives, the course is aligned. This consistency gives clarity and direction to the students, thus facilitating their learning. However, many instructors may not be aware of the concept of course alignment or its importance. The graphic tool provided here gives a concrete and simple way to check course alignment by plotting the objectives, teaching and learning activities, and assessment exercises together on a table using the cognitive process level verbs of Anderson's et al. (2001) revised taxonomy of learning objectives. Once instructors realize that a course is misaligned, they can make the necessary adjustments. The same process can be applied, on a large scale, to curriculum alignment.

By giving students experience with the four types of knowledge, that is, factual, conceptual, procedural, and meta-cognitive, they will also learn more. Instructors need to plan how students will practice engaging with content that requires these different types of knowledge and not assume that they will learn the conceptual or procedural knowledge by attending lectures or demonstrations. When instructors ask students to reflect on their own learning processes and to assess their learning progress, thus using meta-cognitive knowledge, students will learn the content of the course better.

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