Reality Learning: Teaching Higher on Bloom's Taxonomy

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Abstract

Educational needs of the students attending today's universities are changing. New and experienced faculty need to be prepared to address students that exist in world of free information, have access to multiple technical information sources and desire high levels of stimulation. The challenge is to help students learn critical thinking skills by utilizing resources that are at their finger tips. Reality learning challenges student to use knowledge and comprehension to explore engineering challenges in the classroom.

Much of teaching is focused on the knowledge and comprehension levels of Bloom's Taxonomy. When the focus changes from teaching to learning then the outcome expected is raised to the application, analysis, synthesis and evaluation levels of Bloom's taxonomy. Reality learning enables and challenges students to work on higher levels of Bloom's taxonomy. The goal of reality learning is to engage students' minds using tools and processes including generating information that they may combine in new ways to produce new output.

Blackboard software is used to free up class time. Much of the knowledge and comprehension areas are done using technology. This frees class time for reality learning. Students enter the classroom and find themselves confronted by real current situations. They are expected to take their knowledge and comprehension and synthesize it with all the information they can compile to formulate a solution or practical next steps.

Reality learning is current. It is exciting as students are encouraged to use the resources at their fingertips (search the web) or in vibrating in their pockets (cell phones, Blackberries etc.) They are encouraged to think about how the engineering problem they are confronting might be addressed around the world. If they know an expert, they can call. If they want information they should get it. The competitive genes take over and the classroom experience becomes rich with student led and appreciated learning.

The paper includes examples of reality learning exercises used in the author's classes that show how students are moved up Bloom's taxonomy. Also included in the paper are methods of using class management software to free up class time.

Bloom's Taxonomy

Benjamin Bloom (1956) developed a classification of levels of intellectual behavior in learning. Dr. Bloom's intent was to develop a framework for writing educational objectives. The different levels of his taxonomy are described in Table 1. The system can be used to evaluate the contents of a course or class activity. A typical engineering curriculum gives the student much practice in the lower levels of knowledge, comprehension and application. Students receive less practice in the higher levels of analysis, synthesis and evaluation. The lower levels require less in the way of thinking skills. As one moves down the hierarchy, the activities require higher level thinking skills. The higher level thinking skills will enable the students to succeed in the competitive, international, engineering environment. Moreover unless students can be brought to the higher levels of analysis, synthesis, and evaluation, it is unlikely that most students will be able to transfer material learned in the classroom to real life situations. They may not even be able to apply it to school situations other than the one in which it was "learned." The inability to transfer classroom learning to real situations is most apparent when students are confronted by an open ended design. If they do not know in advance which set of formulas or algorithm to apply and what assumptions should be made, even high achieving students struggle to create realistic models of the situation. Often students attempt to force fit any given data into dimly remembered equations. Reality learning can change this situation.

Level	Description	Verbs Used for Objectives
Knowledge	Recognize or recall information.	define, memorize, record, list, recall, name, relate
Comprehension	Demonstrate that the student has sufficient understanding to organize and arrange material mentally.	restate, summarize, discuss, describe, recognize, explain, express, identify
Application	A question that asks a student to apply previously learned information to reach an answer.	solve, simulate, apply, use, calculate, practice, experiment, show
Analysis	Higher order questions that require students to think critically and in depth.	analyze, investigate, interpret, categorize, classify, diagram, organize
Synthesis	Higher order question that asks the student to perform original and creative thinking.	hypothesize, design, develop, invent, formulate, plan, prepare, propose, systematize, create
Evaluation	A higher level question that does not have a single correct answer. It requires the student to judge the merit of an idea or a solution to a problem.	recommend, criticize, predict, judge, assess, deduce, infer, decide, measure, estimate

Table 1. Explanation of Bloom's Taxonomy.

What is Reality Learning?

Reality learning is a teaching technique designed to give students practice using higher level learning skills, show students relevance of the material and engage students in the learning process. These goals are typically achieved using the following four step process:

1. Students complete an out of class assignment to cover the material at the lower levels of Bloom's taxonomy.
2. In the next class meeting, the professor presents a realistic situation that requires students to confront a problem. Teams of students are assigned to research and analyze the problem. Finally the students recommend a solution or course of action.
3. The student teams present their conclusions to the class. The class, lead by the professor, evaluates and critiques the team's solution.
4. The professor completes the session by emphasizing points that are key to understanding the topic.

The process presented can be modified in many ways to fit the educational goals and time constraints of the class. The key components are a realistic problem, teams of students and a critiqued solution. The realistic problem demonstrates the relevance of the material to the students and engages the students. Working in teams forces the students to test their understanding against the understanding of the other group members and develop solutions. The public critique of solutions allows students to evaluate alternative solutions. These activities are in the synthesis and evaluation levels of Bloom's taxonomy. The main drawbacks of this approach are the increased class time consumed and the increased faculty preparation time.

<u>Today's Learning Environment</u>

Technology is everywhere. The authors have noticed students obtaining information from cell phones or derivative devices, classroom computers and wireless connected laptops. Why should all this be shut down to create a learning environment of the 20th century? Why not recognize that these future engineers have the world at their fingertips and use that to engage them in learning in a way that it might be applied the next day to solve a problem at work?

The second biggest challenge that the authors have noticed in the classroom is technological speed. Students have been raised on television that can bring them the world's problems almost as they happen. They are used to zipping from one station to another or a picture within a picture on television. They are used to getting information for assignments by going to Google® and other web search engines and getting instant feedback. How is a student like this to be engaged by a professor who presents the carefully prepared lecture with plenty of material but no excitement? Another component of speed is the mind speed at which our students operate. They are adept at multitasking. They can simultaneously answer cellphones, search the web and carry on a conversation. Zull (p. 236) suggest that to help with learning you, "must do two things: get the student's interest and appear realistic."[1] Getting the students interest after a long day may not be easily done when appearing in the classroom with a stack of 90 transparencies or even turning on the computer and proceeding through a power point presentation. Where is the student involvement? Where is reality anchor?

One of the opportunities of the 21st century and one of the learning challenges is that information and knowledge have become a free resource. It is out there on the web for the asking, in a phone call, in a library data base etc. In reality learning students learn to find information, evaluate the information and use the information to solve a realistic problem.

<u>Where does the time come from to teach differently?</u>

Faculty members frequently are hesitant to try new teaching methods because of the class time consumed. Fortunately the various classroom software programs like BlackBoard provide tools to push lower level learning out of class time and create time for higher level learning. The authors have experimented with two strategies. The first strategy involves minimizing the class time devoted to administrative duties and the second strategy employs on-line quizzes to ensure students have completed the assigned reading before class.

The first meeting of a class is an ideal place to start to minimize the class time devoted to administrative duties. Typically the first class is taken up with reviewing of the syllabus and getting to know the students. These goals can be better met by using technology outside of class. Traditionally the syllabus is reviewed so that all students understand the ground rules of the class. To save class time, the detailed syllabus can be posted on the Blackboard site so students have plenty of time to review it before the first class meeting. This allows the professor to quickly cover the syllabus by answering the students' questions and highlighting the important parts of the syllabus. Professors can enhance the value of their syllabi by including their expectations in the syllabi. Information like how much time students are expected to commit to the class, the teaching methods employed and the types of class projects required can encourage reluctant students to opt out of the class or at least be prepared.

Many professors like to know about their students in order to create a better learning environment or to tailor the course content to the interests of the students. Instead of asking each student to introduce themselves, each student completes a detailed assignment introducing themselves to the class. Students post their assignment on the class' discussion board for access by all members of the class. Not only is this introduction permanent but it can be tailored to address issues the faculty consider important. If the assignment is "expected" before the first class, the instructor can get to know the students before the class starts.

The ability to administer on-line quizzes using course software tools can be used to quickly move students through Bloom's knowledge and comprehension levels. Instead of using classroom time to introduce the material, students read the material and take an on-line quiz before they come to class. The purpose of the quiz is to have the students arrive at class familiar with the material. The quiz lets students know what you think is important and gives them instant feedback on their knowledge and comprehension. The instructor can review the grades on the quizzes before class and cover concepts that many in the class had trouble with on the quiz. When coupled with a reality learning exercise, quizzes can be very effective. The quizzes do not consume class time and the faculty does not have to grade each individual quiz. The software administers the quiz at a time convenient to the student and automatically enters the grades into a spread sheet. Faculty should log on periodically to be sure there are no major problems but the system is self-operative once set up.

Product Architecture Example

One of the authors' favorite reality learning exercises teaches the concept of product architecture. This activity has been done in junior level and graduate level product design courses. Product architecture is the assignment of the functional elements of the product to the physical building blocks of the product. The choice of product architecture influences the cost of the product, the development time required and the ease of introducing product variants. Choosing an architecture requires balancing many competing objectives. Before the introduction of a reality learning exercise, the topic was covered using traditional lecture methods. When students went to apply the concepts to projects they were completing for class, the results showed a lack of understanding of the topic.

The reality learning exercise on product architecture begins with a reading assignment and on-line quiz. Students complete both before the class. At the beginning of class the instructor answers students' questions about product architecture and assesses their understanding by discussing the architecture of common products. Next several variants of common consumer products are handed out. The most recent product investigated was cordless screwdrivers. Teams of students disassemble the product and identify the architecture of the product. The students present the product, their assessment of the architecture chosen, why they believe the designer chose the architecture and the benefits of the architecture to the class. The class evaluates their reasoning and conclusions.

Then a letter from the Vice President of Marketing of a fictitious manufacturing firm is presented to the class. The letter identifies five markets that the company would like to enter. Examples of the five markets are shown below.

1. Reconstruction contractors in Iraq
2. Commercial construction Market in China
3. High Tech (as in Shaper Image®) in the United States
4. Aging European Market
5. Hispanic Market in the United States

Collectively the class goes over each market and tries to think of features that would be attractive to the specific market. Starting with what the student knows is recommended by Zull.[2] Next the students are encouraged to use the resources on hand to get information about the target market. Generally the faculty recommend some web sites and the students find others. Some students call friends or family who they think can help. For engineers understanding how quickly they can get market data is very important. Many are amazed to be exposed so something as simple as a web site containing the CIA World Fact Book[3], which has much information that could impact product design.

After the results are shared, each team is assigned a market and asked to complete a high level design of the product for their market in 25 minutes. The level of activity increases as sketches are produced, debated and revised. The students present their designs to the class. The architecture of each design is discussed. The sketches are hung around the room. Many students believe that the exercise is done. Then the teams are reorganized such that one member from each of the old teams is a member of a new team. Therefore each new team has representative from each of the old teams. Now the students are told that the products designed constitute a family of products manufactured by their company. They are then challenged to redesign the products to minimize the resources required to produce the family of products. This forces the students to create common product architecture for the group of products. The task requires the team to work on the highest levels of Bloom's taxonomy. Here their knowledge of the material is tested and refined. At then end of class the revised designs are presented again and the best selected by the class vote. After the exercise the students demonstrated a much improved understanding of product architecture concepts when they applied the concepts to their semester long project.

The exercise on product architecture begins with students completing a preparatory assignment. Since assignment is the first contact the students have with the new material, the students are working at the knowledge level of Bloom's taxonomy. At the beginning of class the instructor leads a discussion to assess the students understanding and address any gaps found. The disassembling of the product and the identification of the product architecture forces students to the comprehension level. When the students redesign the product for a specific market they are operating on the application level of Bloom's taxonomy. The more complex task of creating a product architecture for a family of products pushes students to the synthesis level of Bloom's taxonomy. The students must operate on the highest level of Bloom's taxonomy, evaluation, to attempt to determine the best product architecture for the family of products.

Reality learning can also be applied to engineering science classes. Consider the traditional statics course. Many professors and students are familiar with the classic problem dealing with the forces in a set of ropes used to pull a car out of a ditch. Usually the weight of the car, the angle of the ropes and all other required data is given. Students dutifully apply the concepts and arrive at an answer. Suppose that small teams of students were assigned to solve a similar problem. This time, however, the make and model of the car is the only data supplied. The ropes, the angles, the winches are all chosen by the students. Now the students are designing the system to pull the car from the ditch. The specifications for the equipment that could be used to pull the car out of the ditch are available on the internet. The instructor could direct the teams to design the system to minimize the cost or the total forces in the ropes. The teams could present their solution to the class for discussion and critique. By restructuring the problem, students are required to work at higher levels on Bloom's taxonomy. Not only does this increase the likelihood of the students being able to apply the learning to new situations, it also changes the format of the class from the traditional lecture model to a more interactive model.

Conclusion

Creating and delivering reality learning experiences takes time and effort. A realistic situation must be created, preparatory assignments must be compiled, class time must be carefully planned and Bloom's taxonomy must be consulted. Even with detailed planning, some trial and error refinement should be expected. Fortunately the benefits outweigh the increased resources required. The ability to operate on higher levels of Bloom's taxonomy is required for a successful career in today's globally competitive job market. In addition reality learning shows students the relevance of the material they are learning. Relevance engages and motivates students. Finally reality learning experiences replace the static lecture model with a dynamic, student-driven learning environment.

References

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2. Ibid.
3. CIA World Fact Book http://www.cia.gov/cia/publications/factbook/

Biographic Information

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