4-8-2009

Knowledge Surveys

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Abstract: A knowledge survey consists of course learning objectives framed as questions and is given before and after the content of the knowledge survey is presented in class. For each question on the knowledge survey, students respond using a three-point rating of their confidence to correctly answer the question. Knowledge surveys may be used as a pretest before the semester or a new unit begins to help faculty get a sense of what students believe they know about upcoming topics. Knowledge surveys may be conducted electronically through Blackboard or as an in or out of class assignment on paper.

Overview of Knowledge Surveys

A knowledge survey consists of course learning objectives framed as questions and is given before and after the content of the knowledge survey is presented in class. For each question on the knowledge survey, students respond using a three-point rating of their confidence to correctly answer the question (i.e., they don't actually answer the questions):

3 = You feel confident you can answer the question correctly right now.

2 = You can answer at least 50% of the question or you know precisely where you would go quickly to get the information needed and could return within 20 minutes to provide a complete answer.

1 = You are not confident you could adequately answer the question at this time.

A knowledge survey can cover an entire curriculum, an entire course (most common in my experience), a multi-week unit, a single lecture or even a single topic. In the case where the knowledge survey covers the entire course, the survey is given at the very beginning and very end of the semester. Were a knowledge survey to cover a single lecture, it could be given at the start and end of a course period. Some of the uses of knowledge surveys are described in more detail below, but one possible application is that knowledge survey items can be correlated to Bloom's taxonomy to help the instructor develop an understanding of the level of thinking required in the course

Snapshot of a Knowledge Survey

To develop the set of questions included in a knowledge survey, one may start by collecting homework, quiz and exam questions given in the course. Pre-defined learning objectives are also ideally suited to becoming knowledge survey items. Items should be phrased as "I can"

statements, as in, "I can calculate the shear stress at a distance r from a dislocation." Some other examples include:

1. Make a contour plot that shows the locus of points with a single value of the function.
2. Determine the coefficients for a Fourier series representation of a function.
3. Illustrate an example of each of the four basic symmetry operations.
4. Calculate the spacing between dislocations which arise in semicoherent interfaces.
5. Explain what is happening at the atomic level during elastic deformation.
6. Sketch the change in strength associated with precipitation hardening as a function of particle radius r.

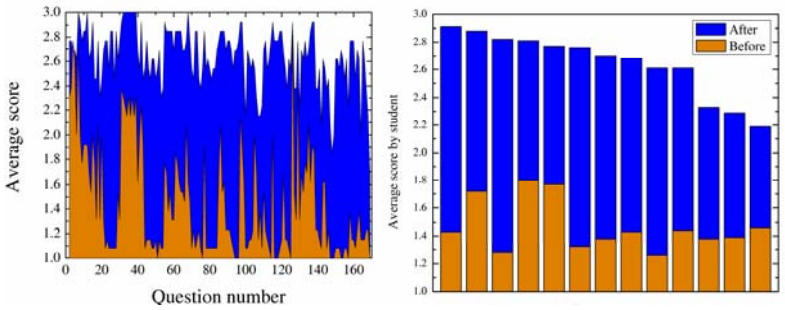
For a knowledge survey that covers an entire semester's worth of material, it would not be uncommon to have upward of 200 questions; for a single topic, five to fifteen questions would be appropriate. If developing a knowledge survey for an entire course, it may be helpful to develop a set of knowledge survey items that corresponds to each week in the course or to each lecture.

Interpretation of Results

A knowledge survey represents a global view of student confidence (which might or might not correlate well to knowledge) of subject matter. There are two main ways to graphically understand the results from a knowledge survey. In the left figure below, average student responses to each item on the knowledge survey (of which there were ~170) are shown before (orange) and after (blue) the semester. Items where they scored high before show which topics have been sufficiently covered in other courses or where students have good prerequisite knowledge. Likewise, items where they scored low before show they have no knowledge of this material. By considering the average scores after the course, the instructor can identify where they have learned a lot (high scores) or not acquired sufficient knowledge (low scores). It is then up to the instructor to determine why students have less confidence for some topics (very often because the subject was only glossed over in lecture). Individual items can be further analyzed to find where the biggest gains were made, which concepts have best taken hold, and which still elude students.

A second interpretation involves looking at the average response by student before and after the course. Again, it is important to remember that a knowledge survey measures confidence in knowledge, not actual

knowledge. Some students may be overly confident while other underestimate their own knowledge. That said, the plot below on the right shows the average response to all 170 items by student (13 students in course) before (orange) and after (blue) the semester. Before the semester, the average response was about 1.5 and after was about 2.5.



Implementation of Knowledge Surveys in Materials Science and Engineering

The following observations come from the implementation of knowledge surveys in the courses I have taught in the last three semesters (MSE 305: Bonding, Crystallography and Crystal Defects, MSE 312: Mechanical Behavior of Materials, MSE 465/565: Applications of Mathematica in Materials Science and Engineering).

Knowledge Surveys from the Instructor's Perspective

- The knowledge survey serves as a guide for my preparation for the entire semester. After identifying the items I feel are most important to teach in the course (i.e., those that show up on my knowledge survey), I have a guide that can be referred back to at anytime during the development of course materials to make sure I stick to the objectives I have identified.
- When creating lectures, homeworks, quizzes or exams, I look to the knowledge survey to develop the questions or problems I will pose.
- Students no longer ask "what's going to be on the test?" because I have already identified for them (and myself) which items are likely to show up on exams (the most important ones!).
- A knowledge survey works as a unique tool for assessment (broadly) and student self-assessment. Students can gauge their own level of learning in the course by completing the knowledge survey, for example, before an exam. If their confidence is low on many topics, they should understand that means they are likely ill-prepared for the exam.
- In general, knowledge surveys are easy to implement and modify as needed (see below for more on the mechanics of implementation).

- By asking some questions on the knowledge survey related to the prerequisite knowledge needed for the course, the instructor can gauge student preparedness. In addition, if students have high confidence in topics to be presented in the course, the instructor could modify the course material to place less emphasis in these areas. If students have low confidence on certain prerequisite topics, the instructor knows that some additional background material might need to be covered.

Knowledge Surveys from the Students' Perspective

According to student responses on evaluations related to the knowledge surveys, students report the following benefits of using a knowledge survey:

- Students feel that they know exactly what they are expected to learn in the course.
- The knowledge survey indicates exactly what should be learned and, if they don't know the material on the survey, they feel it is their fault for not covering or reviewing it.
- Knowledge surveys give students an idea of what topics the instructor finds most important so that students may better focus their attention and time.
- Knowledge surveys can be used before quizzes and exams to help study the concepts.

- Knowledge surveys can provide ideas on how to start homework problems.

How and When to Administer a Knowledge Survey

- The knowledge survey should be given at the beginning and end of the course, unit, or lecture (depending on its scope).
- The knowledge survey could be administered through Blackboard (as a survey), made into a form in Excel (or other spreadsheet program), or distributed on paper. The instructors comfort level with each medium and the length of the survey will determine the best method. It is possible to import a set of questions into Blackboard which will be easiest if the knowledge survey is very long.
- It is useful to ask students to provide a name with their responses so that you can correlate the before and after performance of individuals. To provide some measure of anonymity, students can provide made up names as long as they remember and provide the same name at the end of the semester.
- It would be difficult to develop a knowledge survey for an entire course before ever having taught the course, as the instructor will likely be refining the content more during the first time teaching as compared to in subsequent years.

Summary

A knowledge survey is a valuable tool in the classroom for both instructors and students alike. Individual instructors will find many ways to use a knowledge survey to suit their own needs. Once developed, a knowledge survey should remain a living document which can help an instructor modify a course from semester to semester and refine the course content to best enhance student learning.

Additional Resources

1. E. Nuhfer, “The Knowledge Survey: A Tool for All Reasons”
2. K. Wirth, D. Perkins, “Knowledge Surveys: An Indispensable Course Design and Assessment Tool”