

Interviews

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WHY USE INTERVIEWS?

In depth "structured" interviews with a handful of carefully selected students will enable you to readily judge the extent of understanding your students have developed with respect to a series of well-focused, conceptually-related scientific ideas. This form of assessment provides feedback that is especially useful to instructors who want to improve their teaching and the organization of their courses.

WHAT IS AN INTERVIEW?

A formal interview consists of a series of well-chosen questions (and often a set of tasks or problems) which are designed to elicit a portrait of a student's understanding about a scientific concept or set of related concepts (Southerland, Smith & Cummins, 2000). The interview may be videotaped or audiotaped for later analysis.

WHAT IS INVOLVED?

- **Instructor Preparation Time:** Several hours required to develop a set of good questions, tasks and problems sets. Additional time to locate appropriate props and recording equipment, if desired.
- **Preparing Your Students:** Interviews are most fruitful when the student has developed a good rapport with you. It is essential that the student feels relaxed and at ease.
- **Time Requirements:** One-on-one or small group interviews may be conducted in less than an hour in your office or other convenient "private space." Some practice will reduce the time required to conduct a good interview.
- **Disciplines:** No disciplinary constraints. Appropriate for all SMET fields.
- **Class Size:** Normally, structured interviews are conducted outside of class. It is important that subjects be carefully selected to represent a range of ability and interest levels among students enrolled in a course.
- **Special Classroom/Technical Requirements:** Interview protocol, props, recording equipment and small private space.
- **Individual or Group Involvement:** The most useful interviews are those conducted with individuals or small groups outside of class. Sometimes this is done well in laboratory sections, but TAs will need special training or assistance.
- **Analyzing Results:** For "formative" assessment, the instructor may want to review taped interviews with special attention to potential "misconceptions." If used for "summative" evaluation, a type of "scoring rubric" may be developed.
- **Other Things to Consider:** None.

Contents

- Description
- Assessment Purposes
- Limitations
- Teaching Goals
- Suggestions for Use
- Step-by-Step
- Variations
- Analysis
- Pros and Cons
- Research
- Links
- Sources
- More about Mike Zeilik

Description

In its simplest form a structured interview is simply one person asking another person a series of questions about a carefully selected concept/topic or asking her to perform a task. Any materials to be used (props, problems, etc.), many of the questions to be asked, and some responses from the interviewer to expected statements or actions of the interviewee are carefully planned in advance. Importantly, however, the interviewer is free to ask additional questions that focus on issues arising during the course of the interview. It is this freedom to follow the interviewee, to ask for clarifications, and to focus on errors, misconceptions, and gaps in knowledge, that makes the interview so much more fruitful than more traditional methods of assessment.

During a structured interview, the instructor uses a set of questions, called "probes" (and sometimes selected photographs or other props) designed in advance of the interview to elicit a portrait of the learner's understanding about a specific concept/topic (e.g., evolution; molecular/kinetic theory; plate tectonics; binary stars; Newton's laws). The student may be asked to use her own words to explain a concept (e.g., "What is natural selection?") but is typically required to go beyond simple recognition of a concept to construct a detailed personal explanation. Typically the student is also asked to use that concept to solve a problem or other application task (e.g., "Explain why cave fish have no color"). Valuable information is often obtained not only from listening to what the interviewee says, but also from observing what she does, including facial expressions and other body language.

Assessment Purposes

Structured interviews may serve many functions, among them:

- to investigate how well students understand a concept; to identify misconceptions, areas of confusion, and/or gaps in understanding that may be common among a group of students;
- to document how students can apply their knowledge in concrete settings (e.g., problem solving, trouble shooting);
- to document the general and content-specific procedures that students employ in such application tasks and the sequences and manner in which these processes are employed;
- to document how student understanding and problem-solving skills change over time or with instruction; and
- to obtain verbal feedback from students about course structure, teaching techniques and other aspects of the course or program of instruction.

It is also important to note that the goal of the interview is to describe **how** a student understands a scientific concept or phenomenon, and not simply to provide a measurement of the degree to which this understanding approximates the scientific explanation. Thus, interviews are typically used to provide the instructor with insight about students' understandings in order to refine and target instruction ("formative assessment") rather than to evaluate the knowledge of individual students for purposes of assigning a grade ("summative assessment").

Structured interviews are used to describe individual student's understandings of a specific scientific concept or closely related groups of concepts. It is important to note, however, that the degree of understanding to be assessed will differ depending on the type of interview probe used. Can the student recognize the concept? Generate an example? Apply the concept? Use the concept to predict phenomena or solve problems? Different kinds of structured interviews measure different degrees of understanding.

Limitations

Structured interviews are used to describe individual student's understandings, and are best conducted individually with students; thus time is a major inhibiting factor in using structured interviews to inform teaching. To prevent this issue from being prohibitive, selective sampling of a broad range of students in a classroom may be employed to make the technique more practical, yet still provide a portrait of how different students in a class are engaging with course material.

A second limitation of structured interviews lies in the extreme content specificity of students' thinking. For instance, when dealing with biological knowledge, the type of organism included in an interview prompt has been shown to radically change the nature of a student's response. Thus, if an instructor would like to probe a student's reasoning pattern about a specific process (e.g., the change of coat color in response to environmental cues) the nature of the exemplar (eg. the organism) included in the probe must be taken into account (Tamir & Zohar, 1992). Similar specificity may be expected in virtually all scientific disciplines.

Teaching Goals

- Analyzes problems from different viewpoints.
- Recognizes interrelationships among problems and issues.
- Applies principles and generalizations to new problems and situations.
- Demonstrates a basic knowledge of the concepts and theories of this subject.
- Demonstrates synthesis and integration of information and ideas.
- Uses appropriate synthetic and analytic methods to solve problems.
- Communicates effectively.

Suggestions for Use

Because structured interviews can provide a wealth of information about a student's understanding, interviews would seem to be strong candidates for use in formal ("summative") evaluation. However, the use of such interviews for individual evaluation is somewhat problematic. Using structured interviews in formal evaluation requires extended sessions with each student, a luxury that few faculty can afford except in relatively small classes. Instead, careful sampling and interviewing of a select but diverse group of students may permit you to develop an overall portrait of the various understandings that students in your class hold. This kind of "formative assessment" can provide detailed feedback that is very helpful in improving your teaching.

Structured interviews are very powerful tools for gaining insight into students' thinking. They are especially useful in diagnosing "learning errors", "misconceptions", and limitations in reasoning and critical thinking. With some training and practice, teaching assistants may be encouraged to use interviewing strategies in small groups and laboratory sections of large classes. Students themselves often find that knowledge of interviewing is useful in collaborative learning environments.

Step-by-Step

Several types of interview strategies have been developed for use in SMET disciplines (Southerland, Smith & Cummins, 2000). However, the "Interview about Instances and Events" (White & Gunstone, 1992) is possibly the most widely used format for probing understanding about single concepts. In this interview, the student is presented with a set of 10-20 line-drawings, photographs or diagrams that depict examples and counterexamples of natural objects (e.g., a mammal; a volcano; a planetary system; a molecule) or events (eg. a burning candle; a moving automobile; a girl throwing a baseball).

Revealing one drawing at a time, the student is asked to indicate whether it depicts an example of the concept in question, and to provide a rationale or justification. For example, consider a baseball in flight: Is there a "force" on the ball? What makes you say that? Tell me more about that. Or consider a burning candle: Is this "sublimation"? Why do you think that? Can you say some more about that? After each question, the instructor gently probes further into the reasoning the student uses and encourages him/her to elaborate on the responses to provide as complete a picture as possible of the student's understanding. A few general suggestions for conducting successful interviews:

1. The interview should begin with a focus question that requires application of the concept to be investigated, without forcing the student into an explicit definition. A more traditional assessment might ask the student to choose the correct definition of the concept from among four choices or to write down a definition of the concept. The more indirect approach of a structured interview is usually more productive because it allows the student to evince her understanding rather than relying on memorized, rote definitions. This also enables the instructor to gain an idea of how the student applies the implicit concept.
2. Do not force the student into a specific response to each graphic. If the student needs to "waffle" in her answer, she should be allowed to do so. If the student does not have an understanding of the concept that allows her to make a decision about a specific instance, do not force her to choose. This lack of understanding is an important piece of her "conceptual framework".
3. Specific definitions of the concept, if needed, should be sought only after understanding the student's response to the focusing questions. Again, this prevents students from early closure on a rote definition. Thus, in our example, it would be inappropriate to ask, "Well, what is a force (or sublimation)?"
4. It is important for the interviewer to wait at least 3 to 5 seconds after each prompt before trying to interpret the question or ask another. Classroom research has shown that when this "wait time" is observed, both the length of the student responses and the cognitive level of the responses increases (Rowe, 1974).

Variations

As mentioned previously, structured interviews are used to describe individual students' understandings of specific scientific concepts and the degree to which they can apply that understanding. Different interview probes allow for the investigation of different degrees of student understanding.

Instances Interviews

In Interviews about Instances, a student is presented with a specific set of examples and counterexamples of the concept of interest and is asked to identify which cases are examples of the concept, and then to explain that decision. For practical reasons the examples are usually graphics such as line pictures, drawings, or diagrams.

Prediction Interviews

Prediction Interviews require students to anticipate an outcome of a situation and explain or justify that prediction. The strength of this kind of interview is that it focuses on the ways a student can apply her personal meanings of the concept. And because they require application, prediction interviews are very useful in teasing out what has been learned by rote with minimal understanding from what is meaningful knowledge.

Sorting Interviews

In a Sorting Interview, the student is presented with a group of objects and asked to sort them according to specific instructions. This exercise can be structured in many different ways to match the purpose of the assessment. For example, the interviewer may present a series of graphics depicting some natural phenomenon. The student may then be asked to select any number of cards to be used in any order to explain the phenomenon. Alternatively, a student may be presented with a set of genetics, physics or chemistry problem cards and asked to sort them according to similarity (e.g., Smith, 1992). As with other kinds of interviews described in this CAT, the student is encouraged to talk about her reasoning as she attempts to construct an explanation for her sorting.

Problem Solving Interviews

In a Problem Solving Interview, a student is asked to attempt to solve a problem while “thinking aloud,” explaining as much as possible about what she is doing, why she is doing it, and what her symbols and actions mean. Problem solving interviews focus more on a student's performance as a means to assess knowledge, although understanding the student's conceptual framework remains the overarching goal in conducting the interview.

Analysis

Note-taking during an interview can be beneficial, but it generally provides only a superficial picture of a student's meaning. Instead, it is usually beneficial to record the interviews, allowing for more intensive data analysis. As with most classroom assessment activities, analysis of interview data may be accomplished in a variety of ways, with some methods capturing a richer and more multilayered perspective than others.

In order to analyze the results of structured interviews, we suggest that the instructor attempt to put her expectations aside to the extent possible, and instead review the tape or read the transcript with a fresh "eye," allowing important trends from the learner's responses to emerge. Ideally, a sample of interview transcripts should be reviewed several times, so that ideas emerging from one review can inform subsequent readings. As strong trends are noted throughout several interviews, negative examples (occasions for which the tentative trend fails to hold true) should be searched for. This inductive approach to data analysis, i.e., looking for similarities and differences in sets of data, allows for a more informative and reliable portrait of learners to emerge.

For most instructors, a detailed analysis of transcribed interviews is a time-consuming luxury that can't be afforded. However, a review of a taped interview can reveal much about a student's understanding that is not readily discerned in the course of a more casual discussion. Viewing or listening to taped interviews with colleagues or teaching assistants can provide multiple perspectives of the same student, and offers a collaborative opportunity to share a set of common problems.

Pros and Cons

- Structured interviews enable instructors to examine the degree of understanding a learner has for a scientific concept or closely related group of concepts.
- Interviews offer instructors a vehicle for focusing on how instruction is interpreted and internalized by the learner.
- Faculty can use structured interviews as a powerful type of formative assessment to improve courses and teaching methods.
- Collaborative analysis of interviews allows faculty groups to develop shared understandings of typical difficulties students have with key concepts.

However,

- Structured interviews are designed to elicit how a student understands a scientific concept. As such, they should be used in addition to, not instead of, other forms of evaluation.
- Interviews are quite time-consuming. We suggest that faculty interview a broad sample of students in a class in order determine how students are reacting to and understanding concepts presented in class.
- The usefulness of the interview technique is largely determined by the nature and quality of the probes and follow-up questions. Thus, a substantial amount of planning may be required to design an informative interview.

Theory and Research

Historically, use of the structured interview as a means of investigating the process of learning began with Jean Piaget's "method clinique." Trained as an invertebrate zoologist, and working in Binet's (the IQ inventor) laboratory during the 1920s, Piaget became interested not so much in measuring intelligence as in trying to understand the intellectual mechanisms used in the solution of problems and describing the mechanisms of reasoning.

Since that time the structured interview has evolved into a way of framing a dialogue between the student and the instructor in which the student is asked to talk freely about a concept or topic and/or to perform some task while thinking aloud. It has become the qualitative method most widely used to explore how students understand natural phenomena.

Many have found that structured interviews are sufficiently valuable to justify the amount of time and labor they can require. Because they allow students to express what they know and how they apply that knowledge in their own words in, they offer insights not typically obtained by other methods (Southerland, Smith & Cummins, 2000; White & Gunstone, 1992). Such interviews can allow instructors to develop subtle insights of students' conceptual understandings that have been shown to be very useful in planning and refining instruction (Bishop & Anderson, 1990; Lewis & Linn, 1994).

Many studies have been conducted using structured interviews to describe students' conceptual knowledge and how that knowledge is applied in the "real world." Studies to date have employed a great variety of interview types including: interviews about instances (White & Gunstone, 1992; Demastes-Southerland, Good & Peebles, 1995a), prediction interviews (Demastes-Southerland, Good & Peebles, 1995a, 1996; Smith, 1992) and problem-solving or process interviews (Fredette & Clement, 1981; Lewis & Linn, 1994; Smith & Good, 1984).

Unfortunately, there is very little research comparing knowledge of student understanding generated by traditional examinations and the picture generated from structured interviews. In a study that compared descriptions generated through a variety of probes, Demastes-Southerland, Good & Peebles (1995b) determined that the results of prediction interviews were consistent with students' performance on traditional testing measures. Interviews about instances and word sorts, however, were found to generate portraits of a learner's understanding that were very different from those generated by exam responses.

In recent years many researchers have come to the conclusion that the most complete view of a student's conceptual understanding is probably obtained by using a combination of both qualitative methods (such as interviewing) and more traditional quantitative methods (such as traditional multiple choice exams) where the choice of the particular form(s) of each is tailored to fit the research question. Studies that employ multiple research probes have a high mode validity and are more likely to fully and adequately represent a learner's understanding (Songer & Mintzes, 1994; White and Gunstone, 1992).

Links

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Mike Smith

When I started doing problem-solving interviews in 1982, it was the first qualitative dissertation in the Florida State University School of Education in over fifty years. There were no courses to teach me how to conduct them; I was on my own to learn. These days there are lots of excellent books available and courses in most graduate schools or friendly, experienced faculty members around to help you get started. One thing I learned from that experience, however, is that with some reading, careful planning, and practice you can do a pretty acceptable job of interviewing without a lot of help.

For a long time, biology instructors had found that teaching genetics, and specifically teaching how to solve genetics problems, was a very difficult task. The purpose of my dissertation study (Smith & Good, 1984) was to find out how people at different levels of expertise solve genetics problems so that we could use that information to design more effective instruction. What we learned during those "think aloud" interviews was very instructive, and much of it was unexpected.

One of our findings was that students often try to memorize the visual "picture" of a solution of problems they have seen worked in class instead of learning how to figure out a solution. Nowadays, whenever I teach this class, I take a few moments to talk about how genetics is different from history, and that for genetics, memorization is less important than understanding and applying knowledge.

One of the most surprising findings of early research was that students also confused the terms "gene" and "allele," which severely limited their genetic understanding. To our surprise, we discovered that geneticists and genetics texts often add to that confusion by using those terms very loosely. As a result, in the years since, I have always stopped mentally before using those terms with students to make sure I was using the terms accurately.

Later in my academic career, I became acutely aware that one of the reasons students have trouble with genetics is their lack of understanding of mitosis and meiosis. Given that American students study these phenomena several times before they get to college (sometimes as early as the fourth grade; sometimes as many as seven times before they enter medical school), it was surprising to recognize that their knowledge was so faulty. Why the knowledge of nuclear division is so inadequate after so much instruction on the topic even for some of our best students was baffling. This observation led to a series of interviews in which we asked individuals with varying levels of expertise to explain the processes of mitosis and meiosis at the board (on videotape). Eventually this study led to a series of recommendations on how to improve instruction on this topic (Smith, 1991).

Again, confusion over language proved to be an important barrier to understanding with students confusing doubling with pairing, dividing, and replicating. A common misconception among many of our students was that a two-chromatid chromosome is the product of the joining of two one-chromatid chromosomes, not of the replication of a single one-chromatid chromosome. The discovery of this misconception explained why students did not understand that sister chromatids are identical to each other and led us to focus more on the origins of sister chromatids in instruction.

These examples show how useful interviewing has been for me throughout my academic career. Most importantly, it has directly impacted my teaching and helped me do a better job of helping students learn.

Sherry Southerland

In the decade that passed between Mike's dissertation work and my own there was a remarkable change in the methods that are used to conduct educational research. When I began my own work at the Department of Curriculum and Instruction at Louisiana State University, Ph.D. candidates were required to become familiar with, if not adept at, using qualitative research methods. While quantitative methods of investigations are still prominent, particularly in more cognitive kinds of studies, qualitative methods are now widely accepted among educational research communities. (Although many of our colleges in the natural sciences continue to struggle to understand the practice.)

A look at my dissertation demonstrates the degree to which White's and Gunstone's (1990) ideas of mode validity influenced my thinking. (*Mode validity* the measure of the number of different kinds of data that are used to generate a research finding. White and Gunstone describe that research into learner's ideas should have a high mode validity to be useful. In my own research, I used several different kinds of interview probes (interviews about instances, concept maps, and cards sorts) to investigate how students learn about biological evolution. Thinking back on this work, the high mode validity of the research design is one of the more noteworthy aspects of this study on conceptual change.

After completing my dissertation, I began teaching science in a rural high school located on the banks of the Mississippi. While I was there, I struggled with the same problems most teachers have, an incredible number of preparations (I was the only science teacher for the high school), too many students to keep track of, and many students that had difficulties expressing themselves in a written format. Although the constraints of teaching made me leave my video and tape recorders behind, I found a place to use the card sorts and interviews about instances that I had previously used in my research. While the class completed small group work, I would call up a variety of individual students from my biology class to use the card sort to construct an explanation of change in the pelage color in a population of rabbits. The explanations they offered in these interviews allowed me to understand how the students in my class were interpreting my instruction on evolution. Although I had been convinced the utility of these sorts of interviews for research purposes, in my teaching I learned to depend on informal interviews as a valuable resource to guide my instruction.