

Student and Faculty Assumptions About the Nature of Uncertainty in Medicine and Medical Education

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Clinical reasoning involves an element of uncertainty. Teaching clinical reasoning involves understanding how students view uncertainty as well as how medical problems are solved. This study uses Perry's model of intellectual development to explore changes in how medical students, residents, and instructors think about the nature of knowledge. A total of 31 medical students, residents, and instructors completed the Widick and Knefelkamp Measure of Intellectual Development revised to focus specifically on uncertainty in medicine.

Consistent with Perry's theory, scores reflected increasing degrees of acceptance of the role of uncertainty in medicine with increasing experience. Based on these results, it is concluded that to improve the effectiveness of teaching problem solving in medicine, faculty must challenge the assumptions held by medical students about the certainty of medical knowledge while teaching the process of clinical diagnosis.

Since the early 1970s, interest in the study of clinical reasoning processes used by physicians has been steadily increasing.^{1,2} Along with these research efforts, attempts to develop medical curricula to improve the problem-solving abilities of medical students have also increased.³ Underlying all of these approaches to the study and teaching of problem solving in medicine is the assumption that clinical reasoning involves an element of uncertainty.

In particular, the assumptions a physician makes about what he knows, how he knows it, and the degree of certainty he has about what he knows, all affect the problem-solving process.⁴ Therefore, any effort to develop or improve problem-solving skills must take into consideration the nature of assumptions held by faculty and students about the nature of certainty of medical knowledge.

Medical students' and residents' assumptions about the certainty of medical knowledge will directly affect their ability to cope with the probabilistic nature of clinical reasoning. Therefore, instructors need guidance for understanding and assisting students who hold varying assumptions.

To begin to explore this important, but neglected, aspect of medical problem solving, a model developed by William Perry is reviewed that describes differing assumptions people make about the nature of knowledge. Preliminary results of an instrument redesigned to assess these assumptions in medical students, residents, and physician instructors is provided, and the instructional implications of these results for the improvement of teaching medical problem solving are discussed.

PERRY'S MODEL

William Perry, a psychologist at Harvard University, conducted a series of interviews with Harvard undergraduates over a period of 20 years. At least once during each of the students' four years at college, Perry asked students to talk about their experiences in college. Perry⁵ concluded that as students proceed through college, their assumptions about the nature of knowledge, the legitimate role of the college instructor, and their responsibilities as learners change. Perry described these changes as a series of positions through which students proceed as they grow and develop during college.

Perry's model of college student intellectual development is a continuum with nine positions. In the early

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positions individuals believe that all knowledge is known and decisions are either right or wrong. As individuals move to later positions, they come to believe that knowledge is contextual and the world is uncertain but that an individual can make assumptions that allow him to act with certainty. For purposes of this paper, the nine positions were compressed to form four main categories. For each category the student's perception of the nature of knowledge, the role of the instructor, and their responsibility as a learner are described. Students' perceptions about the instructor's responsibilities and their responsibilities as learners are crucial aspects in the design of instruction. If an instructor is not credible in the eyes of the students, it hinders his ability to challenge students to think about knowledge in new ways. The four main categories of Perry's scheme reviewed in this paper are dualism, multiplicity, relativism, and commitment.

DUALISM

The first general category of positions in Perry's scheme is "dualism." For individuals in this stage, knowledge consists of right answers. All decisions are either right or wrong. A student who holds the assumption that there are absolute truths in the world views the instructor as an authority. The instructor's responsibility, therefore, is to provide the student with the truth in a clear, organized fashion. Inconsistencies between what is stated in a textbook and what the instructor says are resolved by deciding which authority is wrong; two inconsistent truths are impossible. The dualist believes his responsibilities as a learner are to learn the facts and to be a scribe, recording and memorizing all that is known.

For example, a resident who is a dualist is faced with two drugs of choice for a particular patient. Since for this resident one drug must be the correct choice, he asks the preceptor to tell him which drug he should use. The resident then prescribes the drug selected by the preceptor. When in the future the resident finds circumstances he feels to be the same, he will prescribe the same drug. If the preceptor refuses to give a specific answer, the resident dismisses the preceptor as being a poor instructor or unknowledgeable.

MULTIPLICITY

Eventually, according to Perry, the student becomes confronted with many instances where there are no clear rights or wrongs. This confrontation leads the student to change his perception about knowledge. The student sees the world of medicine, for example, as one where knowledge is uncertain, rather than true or false.

Once an individual shifts into this stage, he believes that all judgments using this knowledge are equally plausible and correct. Consequently, for this learner, both the instructor's and the learner's responsibilities

are to generate alternative explanations for the phenomenon under consideration. Individuals in this position see no criteria by which to select one course of action over another. All alternatives are equally acceptable or so diverse as to be incomparable.

The multiplist resident may find the reasoned selection of a drug of choice impossible because, he reasons, "One drug is as good as another: 95 percent of the time drug A is effective in this situation but occasionally severe side effects have been noted for patients who have a history of hypertension. Drug B is effective 50 percent of the time but does not have any known side effects." The process of decision making for a multiplist is often impossible. Frequently a multiplist will say, "your guess is as good as mine."

RELATIVISM

With the shift into relativism the individual begins to use a process for making "best guesses" in an uncertain world. For the individual in relativism, uncertainty still exists. But uncertainty can be managed by examining the context of the decision: the assumptions, constraints, and goals that exist in a particular situation. Students in this stage believe the instructor's role is to provide knowledge in a context, to state explicitly his assumptions, and to discuss the evidence used for supporting a decision. The students' responsibility in relativism is to demonstrate that they can use a reasoned process of decision making (eg, to demonstrate that they can compare, contrast, and evaluate various solutions to a problem using various types of evidence).

The resident at the level of relativism understands that although all knowledge is uncertain, medication decisions can be made through a reasoned process. The preceptor's responsibility is to help the resident decide which of several drugs has the best chance for success given the context (eg, patient's problem, medical history, method of administration of the drug, availability of trained staff to administer the drug). Sometimes the preceptor thinks out loud as he reviews the drugs under consideration, thereby demonstrating for the resident his process of reasoning. At other times, the preceptor may ask the resident what drug she thinks would be the best drug of choice and why, thereby forcing the resident to explicitly state her conclusions and to define the evidence she is using to support those conclusions.

COMMITMENT IN RELATIVISM

In the final stages of Perry's model, the individual still believes that the world is uncertain. However, in these stages, the individual uses the reasoned process described in relativism to make decisions as though he operated in a world of certainty. Physicians commit themselves to maintaining the health of their patients, even though their ability to provide this care is not

always certain, or their desire to practice medicine eventually may cease, or they may die before they complete their residency. Making commitments in areas such as career, marriage, family, religion, and philosophical beliefs enables the individual to act in an uncertain world. The role of the instructor in commitment is to help the individual explore the implications and responsibilities of his decision (eg, What does it mean to be a physician? How will it affect my marriage? My children?).

In addition, the instructor supports the individual as he begins to act on his commitments and, if necessary, to re-evaluate his decision. The student's responsibility in this stage is to make commitments through a reasoned process and then to act on and subsequently to re-evaluate those commitments.

APPLICATIONS OF PERRY'S SCHEME

Instructors have used Perry's scheme as the basis for designing instruction for college students in a variety of areas: humanities,⁶ career counseling,⁷ history,⁸ science,⁹ nursing,¹⁰ mathematics,¹¹ and graduate education.¹² These efforts have utilized the Perry scheme as a means of understanding how students construe the nature of knowledge.

Once an instructor understands where his students are within Perry's model and where he would like students to be at the completion of his course, the model outlines the intermediate stages through which the student must pass. Based on this information, instructors have designed courses to challenge the student's conception of the nature of knowledge within the specific content domain of the course. Results indicate that changes in both the student's assumptions about knowledge and the learning of subject matter itself can be accomplished effectively through deliberate course design.⁶ The success of Perry's scheme in helping design effective instruction has not been tested in the medical school setting.

METHODS

The strong explanatory power of Perry's framework for understanding differences among students has resulted in interest among teachers of family medicine to determine the applicability of the model for medical students and residents. In response to this need, a preliminary investigation was conducted using an instrument modified to address issues of uncertainty in medicine.

Because of the demanding nature of the instrument, there was no attempt made to obtain a random sample of subjects. All subjects were affiliated with the Department of Family Practice at the University of Minnesota Medical School. Three groups of subjects were used: family practice faculty participating in a departmental teaching seminar; family practice residents

from each of the three years of training; and medical students in a six-week family practice clerkship at one of the residency sites. Directors or associate directors of four residency sites distributed the instrument to residents at their respective sites. The instructor of the family practice clerkship distributed instruments to his medical students. Those distributing forms were told to select three outstanding residents and three at the lower end of their rankings. Subjects returned their completed instruments to one of the authors. Five instructors (63 percent), 3 first-year residents (38 percent), 7 second-year residents (88 percent), 7 third-year residents (88 percent), and 5 medical students (83 percent) returned the instrument.

Widick and Knefelkamp developed the Measure of Intellectual Development, a copyrighted paper-and-pencil instrument used to assess the position of an individual on Perry's continuum.¹³ The instrument consists of two parts. The first part is composed of 8 to 12 brief sentence stems to which an individual responds with two or three sentences. The second part of the instrument includes two essay questions to which an individual responds with one or more paragraphs. For both the sentence stems and the essay questions, the topics are selected to be appropriate for the group that will complete the instrument (eg, faculty, residents, medical students).

The explicit goal of the instrument is to provide stimulus materials that require the respondent to provide an organizational framework for the answer. The format encourages subjects to structure their responses according to their way of processing information. Through analysis of these responses, it is possible to assess the respondents' assumptions concerning the nature of knowledge in that content area. The stimulus materials selected in this study were identified through discussion with clinical preceptors, seminar instructors, and program directors in the University of Minnesota Family Practice Program.

After the fully developed instrument is administered, the assumptions underlying each subject's responses are independently judged by two trained raters. Each stem receives a single score; each essay receives three scores to weight its contribution to the total score. Each score reflects the rater's assessment of the Perry position most consistent with the subject's assumptions about the nature of knowledge as revealed in his response.

The revisions made to accommodate the focus on uncertainty in medicine in the Measure of Intellectual Development precluded the opportunity to use two raters specifically trained to score the instrument at this stage of the investigation. This deficit was overcome through the use of an expert scorer (ie, the co-author of the original instrument) who, in the future, would be responsible for the training of raters. The expert scorer blindly rated responses to each of the stems and essays for all subjects.

The scores on the stems and essays were tabulated,

and the percentage of each subject's responses categorized at each Perry stage was then calculated. The subject's Perry position was determined according to the following criteria: If 70 percent or more of the scores fell into a single stage, that stage was considered to be the subject's only position. If more than 25 percent, but not more than 69 percent, of the subject's responses were rated within a position, then those positions were considered to be the subject's Perry stage. In this case, the stage receiving the largest number of ratings was considered the dominant stage and the second stage was considered subdominant and was enclosed in parentheses. For example, one first-year medical student had 63 percent of his responses rated as multiplicity and 37 percent rated as dualism. Therefore, multiplicity was considered to be his dominant stage and dualism as his subdominant stage. Because of the exploratory nature of this study, only the dominant scores are reported.

RESULTS

Table 1 displays the results for all subjects by experience level. Three of the five medical students were rated to be in the dualist stage. While their view of the nature of knowledge is based on a belief in right and wrong, some uncertainty has begun to enter their thinking. For most, that uncertainty takes the form of "the right answer is not known yet, but in time it will be" (eg, the cure for cancer will someday be discovered). None of the five medical students demonstrated that they have come to believe that all knowledge is uncertain.

All three of the first-year family practice residents were found to be in the dualist stage, where uncertainty is not possible. One of the three first-year residents indicated an awareness of legitimate uncertainty, but it was an uncertainty that will be resolved given time and research.

Five second-year family practice residents and five third-year family practice residents were found to be in various stages of multiplicity, where an increasingly large amount of what is known is open to interpretation. However, none of the residents was rated as able to resolve that uncertainty through a reasoned process. In fact, only one individual, an instructor with more than ten years of teaching experience, was rated to be in the relativism stage (some of his responses were in the committed position).

Instructors also tended to score in the multiplicity stage. Initially this result was surprising. However, the items for instructors focused on teaching rather than on the practice of medicine. Individuals in the instructor sample, except for the one person already described, had very limited teaching experience. While new instructors may be aware of the uncertain nature of medicine and may know how to make reasoned decisions with that uncertainty, teaching is a new con-

TABLE 1. DOMINANT PERRY STAGE POSITIONS FROM THE MEASURE OF INTELLECTUAL DEVELOPMENT (NUMBER OF SUBJECTS FALLING INTO EACH POSITION)

Subjects	Dualism	Multiplicity	Relativism
First-year medical students	3	2	—
First-year residents	7	—	—
Second-year residents	2	5	—
Third-year residents	2	5	—
Teaching faculty	1	3	1

text. While aware that teaching is also an uncertain process, none of the instructors had received any formal teacher training and therefore may have had a limited awareness of the knowledge, strategies, and skills used to make reasoned judgments about instruction.

What appears to be a regression on the part of first-year residents may, in fact, be the same phenomenon as the new instructors' experience. First-year residents operate in a new environment, with new responsibilities and with the expectation, at least among themselves, that they are "knowledgeable" physicians. After four years of medical school training, they expect certainty in themselves and in those around them.¹³

DISCUSSION

This study uses Perry's model to explore changes in how medical students, residents, and instructors think about the nature of knowledge. A note of caution is important. The Measure of Intellectual Development assesses the assumptions about the nature of knowledge under which an individual is operating for the task domain that serves as the focus of the instrument. Any inferences about an individual's thinking in other task domains must be made with care; an individual's behavior in a particular situation is an indication of his knowledge and skills only within the demands of that environment. An example will illustrate this point.

Many people contend that the traditional medical school environment encourages dualist thinking by requiring memorization of vast amounts of information. Residency, in its early stages, may encourage multiplicity by the residents' exposure to many preceptors and instructors with varying points of view; as a result of their environment, residents may learn to be multiplists and to avoid being relativists in order to escape confrontations with instructors. The assessment results of individuals must therefore be considered in the context of their task environments.

The assumptions medical students and residents hold about the certainty of medical knowledge, as they were examined using Perry's scheme, constrain their

ability to make reasoned decisions in a probabilistic domain. If students assume that diseases can be diagnosed with absolute certainty, they may gather excessive amounts of increasingly irrelevant data rather than make a diagnostic decision, a problem-solving strategy that is inefficient as well as inappropriate.

To improve the effectiveness of approaches to teaching problem solving in medicine, faculty must concurrently challenge the assumptions held by medical students about the certainty of medical knowledge and teach the process of clinical diagnosis. For example, a student should be asked to diagnose cases in which several diagnoses are equally plausible. Once a student has failed to establish a single diagnosis in spite of seeking out references, colleagues, and consultants, the instructor should ask the student, "If you can't decide what's wrong with the patient, how do you decide the appropriate treatment regimen?" In this way the student would be forced to confront the fact that physicians cannot be absolutely certain about the nature of a particular patient's problem. This instructional approach would allow the student to concurrently apply a problem-solving approach to a particular patient problem while confirming the uncertainty of medical knowledge and practice through the concrete experience of a real patient.

Explicit strategies for stimulating and fostering the development of problem-solving skills depend on students' assumptions about the nature of medical knowledge. Perry's scheme provides a useful model for assessing individual's assumptions about certainty in medicine and for designing instruction to challenge and to refine those assumptions. Medical reasoning is, after all, the process of making reasoned judgments in a probabilistic domain; as Bursztajn et al⁴ claim, every medical choice is a gamble. Teaching medical students and residents to recognize and to consider the gamble as they solve problems is a major challenge for medical educators.

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