WHAT EVERY TEACHER OF SCIENCE AND RELIGION NEEDS TO KNOW ABOUT PEDAGOGY

by Philip Clayton and Mark S. Railey

Abstract. This essay provides practical tips for effective teaching in science-and-religion courses. It offers suggestions for dealing with difficult questions and creating a climate of shared learning. Along with pedagogical advice, it covers fundamental principles for teaching broadly integrative religion-and-science courses. Instructors are encouraged to reflect on their purpose(s) in offering their course and to formulate specific objectives using the techniques and resources outlined here.

Keywords: instructional innovation; interdisciplinary courses; learning communities; objective-based teaching; pedagogy; religion and science; teaching; web resources.

Where do you teach? Is your institution secular or religious, large or small? Do you prefer religion or theology? More science or more religion? Is there perhaps a third field upon which you like to focus: ethics, environmentalism, psychology or another social science, philosophy, or comparative religion? What are your strengths and weaknesses in attempting to cover a field as broad as religion and science?

Each course in science and religion reflects the environment in which it is taught. The instructor alone knows his or her audience and goals in offering the class, choosing readings, and designing lectures. One does not need to be an expert in every field in order to create a learning community. The construction of learning communities is central to powerful pedagogy, since they allow students and other resource people to become co-teachers (something like the "co-creators" in Philip Hefner's well-known conception—except that the professor is assuredly not God!).

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The following pages offer some "nuts and bolts" suggestions, pedagogical tips for those involved in teaching science-and-religion courses. We concentrate in particular on the worries many instructors have about teaching in fields outside their specialty. We also offer ideas for using resources and for designing class sessions, especially in difficult portions of the course.

Dealing with Difficult Questions and Creating a Climate of Shared Learning

There is no disgrace in admitting that one does not know all the details of all fields. A difficult question in, say, quantum physics or chemistry does not have to be the instructor's downfall but could be an occasion for recognizing the immense difficulty in managing the integrative task. What do you do when you come to a topic that you only vaguely remember? One way to approach the topic is through a shared learning experience. You can foster shared learning at the simplest level by "going Socratic," asking questions of students or requesting that they open their texts and read the passage through with you or to themselves. Rather than paraphrasing Ian Barbour badly, it may be better to let Barbour speak in his own words and then to comment as you are able. Or you might ask a student to read a key passage together with students sitting nearby, work together on the interpretation, and then come back from small groups to the class as a whole to discuss the difficult passage.

Work with students to find the sources that will help them answer questions. More learning may occur when they open a basic text to find the meaning of *peptide* or *fideism* than when they are spoon-fed the definitions. We also encourage instructors to use *students* as resources, particularly when they have a strong background in either religion or science. This approach not only wins over hostile students as allies but also creates the ethos of a class with multiple experts and multiple teachers instead of one "expert on everything" who does all the teaching. Let the questions come alive through discussion and puzzling together over them. A parish priest once described the value of beginning with "shared ignorance" and moving together with his study group toward understanding. This sense of a cooperative endeavor can tie students together more quickly than a brilliant lecture by a teacher who knows the answers to all questions.

According to Beverly C. Pestel (1990) of the University of Notre Dame, when students "participate" in the learning experience, they tend to assume greater responsibility. Given that knowledge applied is better assimilated than knowledge memorized, inviting the students to participate in the construction of a portion of the class curriculum—built perhaps around questions that the students themselves have about relating science and religion—often proves helpful in motivating students to

learn. What is needed is a more structured approach to group learning. For example, student-centered learning might involve the use of *learning contracts*, agreements initiated and written by the students and signed by the instructor. Contracts allow students, individually or in groups, to explore topics of their own interest and to present their results in a form they find meaningful (after consultation with the instructor, of course!).

For a slightly more structured plan, we also suggest group research and report projects. The benefits of such projects include first-hand exposure to facts, independent thinking and new ideas, increased learning by the teacher, and extended teaching time; they also train students in cooperation and teamwork, skills frequently requested by industry and business leaders. Group projects work best when clearly defined responsibilities are formulated for both teacher and students. The leader's responsibilities might include: (1) assisting in selecting the problem or issue, (2) helping to determine the research topic, (3) recruiting volunteers to do the research, (4) suggesting or providing the resources, (5) asking for reports from individuals, (6) requesting reactions from other group members, (7) summarizing the main points, (8) suggesting ways to use the research information, and (9) evaluating the group's learning experience. The students' responsibilities might include: (1) assisting in selecting the problem or issue, (2) assisting in determining needed areas of research, (3) dividing up the research responsibilities, (4) doing the actual research using the suggested resources, (5) studying assignments handed out by the leader, (6) selecting relevant data, (7) organizing and reporting results to the entire class, (8) asking questions of others to clarify issues, (9) determining further studies or actions based on these results, and (10) assisting in evaluating the group's learning experience. We often combine group research projects of this sort with the request that students keep a journal or lab manual to record their educational experiences. These journals can be turned in for a grade, used during examinations, or transformed into a final "reflection" paper.

Some instructors find projects of this sort too structured and prefer to use "buzz groups" or informal "talk-back sessions" as part of their pedagogy. Buzz groups are valuable because they promote interaction, involvement, participation, adaptability, and variety; they also have the tendency to promote leadership development and to generate a rich array of ideas. To use buzz groups effectively, a teacher must carefully plan the class session ahead of time—defining the roles of the group members, limiting the time in each session, and summarizing the findings of the groups when the session is over. The teacher usually "floats" from group to group during the session. While this model has the advantage of being simpler, it may not develop the long-term cooperation necessary for more advanced work in science and religion.

Fundamental Principles for Teaching Broadly Integrative Religion-and-Science Courses

A crucial key to success in teaching an integrative course such as religion and science is to find the right level of abstraction. One must choose with care the depth of scientific knowledge to presuppose, the number of scientific theories to cover, the number of religious terms to introduce, and the level of theological expertise to require.

In order to find the right level at which to pitch a particular class in a particular setting, imagine a continuum running from most to least difficult. On the science side, the continuum might stretch from sophisticated summaries of natural scientific data (meter readings and the like), through detailed work on specific scientific theories (Newton's laws or the principles of thermodynamics, complete with mathematics), through more general summaries of scientific theories, and on to accounts that use philosophical and theological terms to explain (or judge) scientific theories from an "external" perspective alone. In constructing the syllabus and teaching the course, the instructor must consciously choose the level of abstraction or detail appropriate to his or her students (and to his or her own expertise!).

The next task is to choose the number and depth of scientific and theological examples. Imagine again the same continuum, but now apply it in deciding how to present a particular example. There are a number of techniques that can be used when preparing to present an example outside your own field of expertise: writing it down verbatim, consulting reference works in the field (the basic texts in particular fields of science are an invaluable resource), talking it through with colleagues in that field, and breaking the class into groups to "wrestle with" the example in question.

Remember that there are many networks and multimedia resources available to supplement a lecture (and to take the pressure off the instructor!). The works in the fields of religion and theology are too numerous to list here. On the science side, resources include the series of films from the Smithsonian Institution, CD-ROMs, reports on scientific news in the popular press, and various web sites on the Internet. One particularly useful site for biology is Genentech's online biology education program "Access Excellence: A Place in Cyberspace for Biology Teaching and Learning," located at http://outcast.gene.com/ae/. One of the authors also recently used the full-text index Lexis/Nexis to put together a five-page "current topics" unit on Dolly, the cloned sheep. Instructions for the use of resource networks and multimedia presentations, as well as for incorporating a "listserv" (a computerized distribution list, so that each e-mail message submitted is forwarded to the entire class) are contained in William Grassie's excellent article "Powerful Pedagogy in the Science and Religion Classroom" (Grassie 1997).

Pedagogical Tips

Have you ever seen a student squirming with what he or she thinks is a "dumb" question, too stupid to ask? What is needed in such cases is a boost in self-esteem and a suggestion on how to get over the "dumb" question barrier. One of the biggest blocks to success in these classes is students' belief that they will not be able to master the material in *both* science and religion in one semester.

Various teaching methods can help allay this fear. List the difficult content questions at the beginning of a particular class session and then ask the students, "Which ones do you now know? Which ones do we need to cover today?" This clearly sends the message that there is much the students may not know, and there are no "dumb" questions. For building self-esteem, provide challenging yet reasonable learning activities. For example, the instructor might ask the students to meet in small groups during one class period to develop a checklist of possible conflicts between a particular scientific theory and religious belief. For each item in the students' list, they should include a response that shows how the potential conflict might be resolved. Exercises such as this help students interact personally with the specific content covered in the class. Especially in an ambitious field such as religion and science it is crucial to provide a supportive environment. Here are some tips: avoid extensive negative feedback; counsel as often as necessary; use verbal encouragement in class; help students feel satisfaction when they are sucessful; and provide opportunities for further discussion outside class. The more comfortable students are with their instructor, the more comfortable they will be with the material.

What about that student who just doesn't do well? If a student does poorly on a test, it may be for several reasons. There may have been too much material to retain. The important material may have been weighted at the same level as other material. The test questions may have been too ambiguous (you might suspect a problem if students often ask, "What do you mean by that?"). You may have taught one way and tested another. The exam may have been too long. The student may have poor retention skills or blocks. The student may have mistakenly believed that time spent in class is the same thing as studying. He or she may not have attended class frequently enough (announce important dates in advance!). Perhaps you haven't made your expectations clear. Some students are skilled at studying the teacher's idiosyncrasies more than the class content.

One way to ensure that everything is "above board" is to construct clear objectives. Learning is enduring change brought about by practice, and practice is empowered through clearly defined course descriptions and objectives. We advocate formulating course descriptions in terms of learner competencies. Why? In this case, the stated objectives legitimize

class sessions and tests. Tests measure the learner's competency in doing the thing(s) described in the objectives. Clear objectives help to motivate the learner; they also aid reviewers in recognizing how the course fits the institution's educational goals. With clear objectives in place, the teacher can teach the student, not the course.

According to Robert F. Mager, an objective is a description of a performance you want learners to be able to exhibit before you consider them competent (e.g., Mager 1984). Each lesson specifies objectives; performance, conditions, and criteria of acceptable performance are clearly described. Learning activities can then be designed to be appropriate to the objectives, and tests can be constructed in keeping with the objectives. It is true that educators differ over how measurable objectives are to be used in course design. Overly strict objectives not only tend to be cumbersome but also may limit learner potential and growth (Eisner 1985). Still, as B. S. Bloom and associates note, "Man [sic] is apparently so constituted that he cannot refrain from evaluating, judging, appraising, or valuing almost everything which comes within his purview" (Bloom et al. 1956, 185). Clearly defined objectives help students positively evaluate their learning experiences.

For starting a session, the teacher should use techniques that stress *process* rather than *a single set of conclusions*. Circle responses and agree-disagree questions provide good discussion starters. In the *circle response*, the teacher poses an opinion question, and each person in turn shares her or his answer to the question. Students must respond orally, and they must not answer yes or no. After each person has shared his or her response, the instructor summarizes key points from the exercise. In preparing, the teacher should anticipate various answers to the question and be prepared to refine points or to guide the resulting discussion. (It is best to use this technique with groups of twenty or fewer because of the length of time required for each person to answer.) This method helps the teacher to identify concepts and attitudes and then to guide the group into the topics of the day.

The *agree-disagree discussion starter* is a sheet (prepared and duplicated in advance by the instructor) containing a series of statements on a particular subject that are worded in such a way as to draw attention to divisions of opinion. The questions should be debatable and contain those key words that need interpretation or further definition. Each class member receives a sheet and is given sufficient time to complete it. The teacher reads the statements one at a time, asking students to indicate by raising their hands whether they agree or disagree with the statement. After all have indicated their responses, the teacher goes over the most controversial statements (as indicated by the responses of the class). Those who agree tell why they agree, and those who disagree tell

why they disagree. The teacher then directs the class to the day's reading or other resources to determine what experts have said about the subject. It is not necessary to discuss every statement; more important is to discuss a few statements thoroughly. Obviously, teacher preparation is crucial, since one must study both (or all) sides of the questions and anticipate answers. Still, agree-disagree sheets represent an effective way to stimulate discussion as well as student interaction with the resource materials.

These two approaches are introduced to emphasize a fundamental point: the key to navigating a religion-and-science course successfully is to employ a rich variety of pedagogical techniques. A teacher can use pictures, charts, lists, and multimedia aids. Before detailing his or her own answer, the instructor should present a typology of viable responses to the question. Other voices should be admitted to the discussion through the use of guest lecturers, team-taught class sessions (where appropriate), and small-group exercises. In both science and religion, metaphors and analogies are effective teaching tools; students may learn a scientific theory better by means of a narrative of the process of discovery than by more didactic methods. The teacher can focus on ethical implications of scientific theories and methods, or he or she may draw out the implications of theories for actual religious or scientific practice.

When an instructor moves from teaching theories in science and religion to areas of controversy and evaluation, we strongly recommend stressing *process* rather than a single set of conclusions. At this point the use of small-group exercises is indispensable. For example, dyads or triads of students can present the reading, summarize the major options, and lead the subsequent discussion. As co-participants in the learning process, students must be encouraged to formulate their own responses. The teacher then becomes a facilitator of learning—restating, refining and contextualizing student comments.

EXAMPLE

The successful class session or topic unit draws on a variety of educational experiences. As a sample, we include a lesson plan on biogenesis created by Mark S. Railey (adapted from a similar plan presented by Dawn Adams of Baylor University at the winter, 1997, workshop of the John Templeton Foundation Science and Religion Course Program presented in Berkeley, California, by the Center for Theology and the Natural Sciences).

- Area of Change: Knowledge.
- Lesson Objective: The learners will be able to recount orally the basic principles of evolutionary theory.

STEP 1

- Principle: The learner is involved in numerous and varied activities related to the same objective.
- Method: Have learners divide into groups of two. Read handouts on evolution in ten minutes, and then summarize the key points. Watch video excerpts on evolutionary concepts.
- Aids: Evolution handouts; VCR/TV; videotapes.

STEP 2

- Principles: The learner is involved in activities which call for active response, and the learning activities involve more than one of the senses.
- Method: Have learners draw from pictures and physically articulate (where possible) the joints of the leg of a human, horse, cat, and pterodactyl.
- Aids: Pictures of legs; pencils and worksheets; skeleton of leg of human, horse, etc.

STEP 3

- Principles: The learner knows results immediately (whether right or wrong). Activities are provided in which the learner uses advance organizers. The learner is involved in novel activities in regard to the information.
- Method: Travel to the zoo. Divide into three groups. Have learners go on a "scavenger hunt," drawing pictures of evolutionary features. The team finished first wins a prize (stickers).
- Aids: Transportation; tickets to the zoo; scavenger hunt lists and pencils; prizes.

STEP 4

- The learner reviews systematically.
- Method: Rally the groups. Pass out biogenesis handout. Review evolutionary concepts in short lecture. Have the learners orally recount the principles of evolutionary theory.
- Aid: Evolutionary theory review handout.

The Root Question: What Is Your Purpose in Offering the Course?

When the instructor keeps in mind the question of purpose, it is much easier to decide when to advocate a particular position strongly and when to list multiple options and allow students to reach their own decisions. As long as the objectives of the course as a whole (and of particular units within it) are clear, the goals for individual class sessions and discussions are not difficult to formulate. In this case, students will not feel either manipulated into conclusions or lost in meandering presentations.

Whether the teacher is aware of it or not, he or she is inevitably involved in advocating for one or another position or approach, whether actively or passively. We wish to conclude by advocating for one overarching goal that should overshadow the rest: to create a climate of shared learning and interest. This means designing a science-and-religion course that is an advocacy for the discipline of science and religion itself rather than for any one particular theological agenda within the discipline. Such a course reflects a pluralistic or "dialogical" model of education (Bakhtin 1994), in the sense that it aims to "draw forth" from each participant his or her own contributions to the science/religion discussion.

Note

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