Offering an anatomy and physiology course through a high school-university partnership: the Minnesota model

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INTRODUCTORY ANATOMY AND PHYSIOLOGY COURSES are offered in most 2 and 4-yr colleges, and, to a lesser degree, they are a part of the high school curriculum. A program organized through the University of Minnesota (U of M) allows high school students the opportunity to earn college credit for a nonmajor anatomy and physiology course that is based on inquiry and conceptual learning. Such opportunities for students to earn college credit while still enrolled in high school are increasing in both number and popularity (8). At least four such programs exist within Minnesota. The oldest and most traditional model involves high school students traveling to local colleges and taking courses. Most colleges allow special admission status for individuals who wish to take courses without full-time enrollment or interest in pursuing a degree program. This model greatly increased in popularity in Minnesota when state statute 124D.09 (The Post Secondary Enrollment Options Act) went into effect in 1985. The law provided state funding for tuition, fees, and books for qualified high school juniors and seniors to attend local public and private colleges and enroll in for-credit classes (2, 16). Most students using the program take one or two college courses to supplement their regular high school coursework, but some use it to attend college on a full-time basis.

The second and third models involve courses located within high schools: Advanced Placement (AP) and International Baccalaureate (IB). AP currently offers 34 different college-level courses for high school students, but not anatomy and physiology. Defining features of the AP program include a rigorous college-level curriculum and a single, high-stakes exam required at the end of the course if students wish to pursue college credit for their work. The AP final exams are created, standardized, and validated by The College Board, with assistance from content experts, and graded on a scale from 1 to 5; a score of 4 or 5 and, in some cases, 3 makes a student eligible for credit. IB is a broader program that involves educational programs for students aged 3–19 yr, with courses at the high school level offering students the possibility of earning college credit. IB programs are based on a curriculum with a global focus that emphasizes international perspectives. They typically require students to pass a series of exams throughout the year, as opposed to a single exam at the end of a course. Like AP, the IB program currently does not offer an anatomy and physiology course. IB and AP courses are taught at high schools by certified instructors. These teachers attend a wide range of professional development programs to build skills geared toward facilitating the course curriculum. Both IB and AP programs are widely recognized by colleges and universities, and college credit is often awarded to students who complete the requirements (6).

The fourth model is called a concurrent (or dual) enrollment program. As defined by the National Alliance of Concurrent Enrollment Partnerships, such programs involve teaching college-level courses within local high schools. The arrangement requires a formal administrative partnership between a college and a high school as well as a relationship between a college professor and the high school teachers. Unlike AP or IB programs, concurrent enrollment courses customize their assessments; the college professor works with the high school instructors to develop and implement plans that are equivalent to those used with the on-campus course. If the students meet course expectations with a “D” or better, they receive full college credit, and their grade appears on an official college transcript and is equal in all ways to courses completed on-campus.

Historically, all four models have focused on high-achieving students, but as the models evolve, they are attracting a broader range of students, including those who struggle in high school, first-generation college students, and students within populations that are underrepresented in higher education (8). Increasing popularity in the programs is due to, among other factors, increasing pressure on young people to earn a college degree, economic pressure to accrue college credits before enrollment due to rising tuition costs, and political pressure to speed up the 4-yr college experience that is subsidized by tax dollars (i.e., push students to join the workforce quicker).
The U of M’s concurrent enrollment program, “College in the Schools” (CIS), has experienced considerable growth and currently includes over 30 courses, with over 300 high school teachers, and is taught in over 100 Minnesota high schools. During the 2011–2012 school year, 6,484 high school students earned 41,849 college credits through the CIS program.

High school instructors within the CIS program at the U of M are classified as Teaching Specialists, a job category that requires at least a Bachelor’s degree and qualifies an individual to be the instructor of record for select university courses. The CIS program requires all participating instructors to have 3 yr or more of teaching experience, experience teaching advanced courses and students, a valid teaching license or state-approved alternative, and advanced or significant academic coursework in the relevant subject. To be accepted into the CIS program, high school teachers create an application file, including letters of recommendation and support from administrators, and are further evaluated through an in-person interview with the U of M Faculty Coordinator and a representative from the CIS office.

In 2008, the U of M’s Council for Liberal Education (CLE) implemented a new set of graduation requirements that emphasized both traditional student learning objectives (e.g., can identify, define, and solve problems) and also development outcomes (e.g., interdependence and independence). Two documents critical to shaping the university’s graduation requirements and fostering the general philosophy of our anatomy and physiology course were William Cronon’s “Only Connect” (7) and Stanley Katz’s “Liberal Education on the Ropes” (14). Both articles stressed the need for college courses to do more than dispense content; rather, they should strive toward larger goals, such as promoting social responsibility and providing both the knowledge and motivation for students to become world changers. All university courses, both existing and new, wishing to fulfill the liberal education graduation requirements were required to submit proposals detailing how the new objectives would be addressed.

The CLE proposal for our anatomy and physiology course made clear that the science content in the course was intended for nonmajors and that it would not be a more traditional survey course. To emphasize this point, the proposal called for the name of the course to be changed from “Human Anatomy and Physiology” to “Essentials of Human Anatomy and Physiology.” Additionally, the proposal called for an increased emphasis on instructional strategies such as cooperative learning, inquiry, and experiential learning, strategies recommended for college programs by both research (9, 3) and national policy documents (1). The proposal for the course was approved by the CLE Committee as fulfilling university graduation requirements for “biological science with lab.”

Description of the Anatomy and Physiology Course Offered

The four-credit, one-semester anatomy and physiology course (designated as PsTL 1135) offered through the CIS program has been taught every semester of the academic year for 12 yr by its primary instructor (M. Jensen). The course schedule is organized by body systems (e.g., cardiovascular, endocrine, etc.) but, more so, is founded on core principles or “big ideas” of physiology, as identified by Michael and McFarland (17). Concepts such as homeostasis, energy, and flow-down gradients are emphasized throughout the course to promote a conceptual understanding of human physiology. Considerable curricular flexibility is built into the course; there is no set schedule of topics (e.g., 5 h on the integumentary system), but the time requirements for the laboratory component of the course are rigorous and adhere to university requirements: all students in the course must engage in at least 30 h of laboratory experience.

In addition to the delivery of high-quality content instruction, the pedagogical goal of the course is to create a student-centered classroom based on constructivist learning theory (4). (See the APPENDIX for a comparison of constructivist and traditional classrooms.) Such an approach views students as dynamic processors of information; students are required to break down, refine, build up, and sometimes even replace concepts with new ideas, a process that is optimized through social interactions using strategies such as cooperative learning groups (9, 18). To help instructors create a student-centered classroom, both process-oriented guided inquiry learning (POGIL) activities and cooperative quizzes are required on a weekly basis. POGIL is a teaching strategy that requires student to work in cooperative groups to analyze information presented in a model, such as a data set or diagram, to answer direct (i.e., simple), convergent, and divergent questions. The intent of POGIL activities is to promote learning through student-student interactions. The activities are relatively new to anatomy and physiology but have been widely used in other science fields. Brown (5) reported improved test scores in an introductory anatomy and physiology course using POGIL activities. Cooperative quizzes are easy-to-use learning tools that have been shown to effectively promote both positive interdependence between students and individual accountability (13). The activity requires a student to first complete a quiz on an individual basis and then again in a group setting. While students work in groups, only one answer sheet is allowed per group to promote discussion and conflict resolution.

The course also requires students to engage in an experiential learning assignment each term. The pedagogical foundations of experiential learning extend from learning cycle theories (15) that proposed that after students acquire knowledge, they must apply it to some form of action to retain the information. Central to experiential learning is the notion that student learning is enhanced through meaningful interactions with other students and, when possible, the public (15). Using Kolb’s learning cycle approach, students in our anatomy and physiology course first learn about the digestive system and nutrition using both traditional approaches, such as a lecture with PowerPoint, and nontraditional means, such as reading Michael Pollan’s In Defense of Food: an Eater’s Manifesto (19). Students then work in groups to design and develop informational kiosk presentations to engage the broader community in discussions of nutrition and increase public awareness of healthy eating habits and the health complications relating to obesity (11). Students have implemented kiosks during school athletic events, parent-teacher conferences, and even in school cafeterias during lunch periods.

The course design of PsTL 1135 is based on research in science education and recommendations included in national policy documents and has been approved by the U of M as meeting graduation requirements. The same features of the course that make it current and well designed are also the...
features that position it to be offered through a concurrent enrollment program. Instructional strategies such as experiential learning, cooperative group learning, and inquiry-based teaching are often more familiar to high school science teachers than to college professors. The curricular flexibility of the course makes accommodating the wide array of high school course schedules (ranging from 2-h class periods found in block scheduling to 45-min daily classes) possible. The lecture sections of PsTL 1135 at the university have met in rooms ranging from 250-seat auditoriums to 112-student active learning rooms. The course has been most often led by the current primary instructor but has been taught by others with different, but university-approved, job classifications. The laboratory component of the course has met in a laboratory that accommodates 16 students and is led by either the laboratory coordinator or, more frequently, teaching assistants. When offered though the CIS program, the course meets in a traditional high school science classroom that typically contains 28–40 movable desks and an accompanying laboratory. In all cases, the CIS instructor at the high school leads both the lecture and laboratory sections of the course. Enrollment in the course at the university is limited by the number of students that fit into the lecture classroom, but high school student enrollment is most often limited by the number of students that can safely and legally fit into the laboratory, a factor that limits enrollment but in no way confines the curriculum or instructional methods used in the course.

Comparisons of CIS With On-Campus Students

A comparison of the CIS students with those enrolled in the on-campus version of the course reinforces the need for flexibility in the curriculum to accommodate student characteristics (see Table 1). Students who enroll in PsTL 1135 within the CIS program often possess a strong inclination toward science and healthcare careers and frequently indicate a desire to pursue science majors in college. In contrast, many on-campus students take the course to fulfill a science graduation requirement. The on-campus course is challenging but is targeted toward students who plan to pursue careers outside of the biological sciences. A few students each semester, however, switch to health science majors after experiencing the on-campus version of the course.

Ongoing Teacher Development and Support

Workshops for CIS high school teachers are held on a regular basis to prepare instructors to implement the course and to deepen the instructors’ discipline-specific content knowledge. Each summer instructors are required to travel to the university to attend a 3-day workshop. They also attend two 1-day workshops during the school year (fall and spring semesters). Workshops focus on pedagogy and science content. To promote the instructor’s ability to create student-centered classrooms with an emphasis on inquiry, instructional strategies for implementing POGIL activities are reviewed, modified, and critiqued. For example, instructors review the steps of cooperative quizzes and propose modifications such as only allowing nonverbal communication between students for some quizzes. To better prepare instructors for the content requirements of the course, experts in anatomy and physiology provide guest presentations. For example, the summer 2012 workshop featured a presentation on the molecular biology of insulin by Dr. Stephen Katz from the U of M’s Department of Integrative Biology and Physiology, and in spring 2012, CIS instructors attended a 2-day cadaver dissection workshop at the University of North Dakota hosted by Dr. Jon Jackson of the Anatomy and Cell Biology Department.

In addition to speakers and structured presentations, CIS instructors also use workshop time to develop a library of teaching materials. Small groups of teachers (usually 3–4 teachers/group) are assigned a body system and charged with identifying useful materials for the larger group. All resources are archived on a common Internet site (Moodle), where they are reviewed for both accuracy and acceptable rigor by the college professor and then made accessible to all CIS instructors. In addition to finding readings and laboratories, each group is also charged with generating a set of test questions for their assigned body system. Instructors are asked to find, or create, questions that range in difficulty from “easy” to “challenging.”

To promote quality control, the course professor makes site visits to every new high school classroom during their initial year in the program and every other year thereafter. Visits are announced and feature two events: 1) watching the instructor lead a regular classroom or laboratory activity and 2) a question and answer session between the students and the professor. Site visits provide the professor an opportunity to see and experience the culture of each high school and observe the instructors in their own classrooms, thus adding context to understanding the roles, responsibilities, possibilities, and challenges for the high school instructors.

To promote interactions between students from different schools, all CIS classes travel to the U of M campus once a year to attend field days, where they hear lectures from content experts and engage in a competition between schools. The

Table 1. Comparison of University of Minnesota to CIS settings for the anatomy and physiology course

<table>
<thead>
<tr>
<th>Area</th>
<th>University of Minnesota/Campus Setting</th>
<th>High School/CIS Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructor</td>
<td>Professor (PhD)</td>
<td>High school teacher (most have Master's degrees in education)</td>
</tr>
<tr>
<td>Physical classroom</td>
<td>112 students/room</td>
<td>20–40 students/room</td>
</tr>
<tr>
<td>Duration</td>
<td>16-wk semester</td>
<td>36-wk regular academic year*</td>
</tr>
<tr>
<td>Weekly schedule</td>
<td>Lecture: 150 min/wk; laboratory: 105 min/wk</td>
<td>Accommodates high school class schedule, typically meeting every day for 50 min; laboratory must meet a minimum of 30 h</td>
</tr>
<tr>
<td>Student goals</td>
<td>Fullfill graduation requirement</td>
<td>Many are interested in pursuing science or healthcare careers</td>
</tr>
<tr>
<td>Future in science</td>
<td>For the most part, PsTL 1135 is their last life science course</td>
<td>Many will have extensive science coursework when attending college</td>
</tr>
<tr>
<td>Student age, yr</td>
<td>18–25</td>
<td>16–18</td>
</tr>
</tbody>
</table>

*Most schools that offer College in the Schools (CIS)/PsTL 1135 schedule it for the whole school year, but a few using block scheduling (e.g., 10 h class meeting per week) schedule the course for one semester (~18 wk).
Competition features each school’s best experiential learning project (i.e., student kiosk) display (11). The event is held in a large auditorium where all schools can set up and display their kiosks. Students then have the opportunity to view the work of others, comment, and interact. CIS instructors and invited university professors evaluate the kiosks using a scoring rubric that focuses on two broad areas: 1) the accuracy and effectiveness of the physical materials (e.g., graphs, posters, etc.) and 2) the ability of the students to engage in an articulate, factually accurate, and informative discussion of the materials displayed at the kiosk. At the end of the day’s events, awards are given for top projects. Budgetary challenges have made it increasingly difficult in recent years to require attendance from all the schools, especially those with large numbers of students or those that are geographically far from the city. We do, however, emphasize the importance of the opportunity for students and their instructors to attend field days and make every effort to assist each participating school.

Evaluating Program Success

An evaluation of the CIS anatomy and physiology course was completed using program growth and student survey data related to the experiential learning projects. The popularity of the CIS anatomy and physiology program is measured through growth in the total numbers of schools, teachers, and students involved. Table 2 shows that the program grew from an initial 6 teachers and 304 students in 2008 to 20 teachers and 761 students in 2012. While the data shown here do indicate growth, two schools have had to drop the CIS anatomy and physiology course due to low enrollment numbers. Conversations with instructors indicated that the course has a difficult and challenging reputation, which sometimes limits student interest. To maintain enrollment, one teacher made an effort to inform parents of the value of the course through an article within a school district publication. The piece focused on the course’s experiential learning (kiosk) assignment and the value of the course in preparing students for future rigorous endeavors. After the publication, course enrollment increased to a level where additional sections were added. This suggests the importance of good communication with parents as well as students in ensuring program viability.

Data from student feedback gathered through a survey related to the experiential learning assignment were used as a second evaluative measure. Survey questions focused on the two goals of the kiosk project: 1) to not only learn about nutrition and the complications that arise due to obesity but to truly induce behavioral changes and to help students become healthier eaters and 2) for students to begin to view themselves as leaders and advocates in the quest to improve public health by informing community members about the many benefits of a healthy lifestyle and the dangers of a poor diet and obesity. The survey contained questions relating to both dietary habits and advocacy for healthy living and was implemented during the first 2 wk of the 2010 academic year and again at the end of the course. Results from selected survey items are shown in Figs. 1–6. Figures 1–4 show data related to student eating habits and demonstrate trends toward a decrease in the consumption of “junk” food and the increased consumption of healthy food. Figures 5 and 6 show data relating to health advocacy and also show positive trends. After the course, students were slightly more likely to engage others in conversations about healthy eating and exercise. The basic analysis used to interpret the student feedback provided a general affirmation for the kiosk project as an effective learning strategy.

Challenges and Recommendations

Successful college-high school partnerships where “major” courses are offered do exist, but in anatomy and physiology that arrangement creates several problems. The most pressing

Table 2. Growth of the CIS/PsTL 1135 program over its first 5 yr in relation to teachers, schools, sections, and total number of students

<table>
<thead>
<tr>
<th>Year</th>
<th>Teachers</th>
<th>Schools</th>
<th>Sections</th>
<th>Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008–2009</td>
<td>6</td>
<td>5</td>
<td>13</td>
<td>304</td>
</tr>
<tr>
<td>2009–2010</td>
<td>10</td>
<td>9</td>
<td>13</td>
<td>254</td>
</tr>
<tr>
<td>2010–2011</td>
<td>11</td>
<td>12</td>
<td>16</td>
<td>312</td>
</tr>
<tr>
<td>2011–2012</td>
<td>16</td>
<td>16</td>
<td>22</td>
<td>430</td>
</tr>
<tr>
<td>2012–2013</td>
<td>20</td>
<td>20</td>
<td>31</td>
<td>761</td>
</tr>
</tbody>
</table>

Data were provided by the University of Minnesota’s CIS Office (October 2012).

Fig. 1. Summary survey data for eating habits item 1: how many days each week do you consume junk food (e.g., candy bars, chips)?

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of these concerns regards quality control of the content within the concurrent enrollment classes. At this time, there is no valid competency exam or other similar mechanism of measurement to evaluate student learning in human anatomy and physiology. Until such an exam exists, we recommend anatomy and physiology courses offered through concurrent enrollment programs remain limited to nonmajor status. Additionally, we recommend that all anatomy and physiology courses offered through a concurrent enrollment program include site visits by the instructor and regular workshops for content and pedagogical updates.

The top frustration expressed by both the CIS teachers and the primary instructor on the university campus is a lack of physiology-based laboratory activities due to limited equipment and budget constraints. At the university, the purchase of physiology laboratory equipment is more easily justified by the large number of students using it each semester; this is a more difficult cost for high school science departments to justify. The lack of physiology-based activities for CIS students is a matter that will be addressed in future workshops and professional development sessions that will include teachers, a university physiologist, and maybe even biomedical engineers, who together could brainstorm and develop laboratory activities specifically for entry-level physiology students. Until then, all CIS instructors do have a few physiology laboratories, such as estimating a student’s maximal O₂ consumption (\(V_{O2_{max}}\)) levels (12), but they must also engage in many traditional anatomy laboratory activities, such as organ and animal dissections.

Presently, there are several professional organizations dealing with anatomy and physiology in higher education, including the American Physiological Society and Human Anatomy and Physiology Society. Others, like the National Association of Biology Teachers and National Science Teachers Association, focus on high school science teaching. However, there is no one professional home for high school anatomy and physiology instructors. The creation of such an organization, or strand within a currently existing organization, could potentially serve many functions, including the creation of suitable policy documents, recommendations for laboratory activities, a listserv for instructors to pose questions and share ideas, the creation of a
standardized exam, and even recommendations for creating and maintaining concurrent enrollment programs.

Conclusions

The goal of the anatomy and physiology concurrent enrollment program described here is to promote student inquiry and conceptual understanding, and the intent of this article was to outline a few student assignments and teacher preparation strategies used to achieve those goals. Historically, entry-level anatomy and physiology college courses have been content rich and instructor centered and executed primarily through showing and narrating PowerPoint slides. Transferring this teacher-centered model to a concurrent enrollment program would be easy by requiring instructors to use the exact same PowerPoint slides, exams, etc., but constructivist learning theory, which places an importance on accommodating students’ prior knowledge, strongly predicts that such an arrangement would create a poor learning environment for students and likely produce a frustrating experience for high school instructors. Such an approach would likely promote rote memorization over conceptual understanding, and the experience would likely not contribute significantly to student success in more advanced science courses.

By attempting to accommodate student aspirations and prior knowledge, the CIS anatomy and physiology course promotes a more student-centered, constructivist-based classroom. Instructors in the CIS anatomy and physiology program are typically familiar with this approach as it is a common topic in the science education coursework required to attain a K-12 teaching license. But the student-centered approach is often unexpected by new CIS instructors because they are now teaching a college-level course, and they think they must do more lecturing because it is their perception that college professors primarily lecture.

High school students who enroll in the course are also often uncomfortable with the student-centered pedagogy used in the course. To introduce cooperative quizzes, inquiry, and generally set the tone of the course, a letter authored by the course professor is distributed to all students on the first day of class (with instructions to show the letter to their parents as well) (10). To clearly communicate the limitations of the course, all CIS instructors must have the following information in their syllabus and must review the information on the first day of class:

Fig. 4. Summary survey data for eating habits item 4: how many days each week do you consume fresh vegetables?

Fig. 5. Summary survey data for health advocacy item 1: in the last month, how often have you encouraged other people to eat healthier food?
The role of the instructor is to promote uncertainty and doubt, which are good signs of weakness. Student questions are frequently responded to with another question, while fielding and promoting questions. The instructor walks around the room while showing PowerPoint slides. Students are verbal, noisy, or even argumentative while fielding and promoting questions. Focus is on concepts (e.g., ‘homeostasis’) from which the conflict is to be known. Students are viewed as ‘empty vessels’ (i.e., tabula rasa) to be filled with knowledge. Students work alone, but the rewards that come from working with energetic, innovative, and intelligent high school instructors and their students are large and some of the obstacles are formidable. The program is impacting higher education in many ways, and colleges are being asked to work with local school districts to develop more course offerings. These partnerships can be beneficial to all involved if they focus on realistic goals, such as offering developmentally appropriate coursework and promoting student-centered pedagogy.

As the program continues, three areas of research require exploration: 1) How does the focus on inquiry of ‘core concepts’ benefit students as they matriculate to more advanced coursework? 2) What are the benefits of students engaging in experiential learning (construction and implementation of student kiosks)? and 3) What is the broader impact of concurrent enrollment science courses on student postsecondary learning and academic success? The rapid growth of current enrollment programs is impacting higher education in many ways, and colleges are being asked to work with local school districts to develop more course offerings. These partnerships can be beneficial to all involved if they focus on realistic goals, such as offering developmentally appropriate coursework and promoting student-centered pedagogy.

The intent of this article was to clearly describe what we generally call ‘the Minnesota model’ for an anatomy and physiology course used within a university concurrent enrollment program. It also attempts to describe efforts to promote both a positive and challenging program for high school instructors and their students. For instructors, the CIS program offers access to a dynamic network within which to discuss shared interests and challenges and the opportunity to learn new content in anatomy and physiology. For most students enrolled in the CIS anatomy and physiology course, the fact that it is a four-credit college course that fulfills the university’s graduation requirement for biological science with lab is almost irrelevant; it will simply be the first of many college science courses. But students benefit in several less obvious ways, including learning to work in cooperative groups, engaging in scientific inquiry, and learning core principles of human anatomy and physiology. Concurrent enrollment programs support other efforts to transform the nature of undergraduate education and promote increased access to rigorous science content instruction at the high school level. The time and effort required to manage the CIS anatomy and physiology program are large and some of the obstacles are formidable, but the rewards that come from working with energetic, innovative, and intelligent high school instructors and their students make it meaningful and rewarding.

APPENDIX

Table A1 shows brief outlines of major differences between a student-centered or constructivist classroom and a traditional instructor-centered learning environment.

### Table A1. Brief outlines of major differences between a student-centered or constructivist classroom and a traditional instructor-centered learning environment

<table>
<thead>
<tr>
<th>Constructivist Classroom</th>
<th>Traditional Classroom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students are viewed as information processors</td>
<td>Students are viewed as “empty vessels” (i.e., tabula rasa) to be filled with knowledge</td>
</tr>
<tr>
<td>Students work in groups</td>
<td>Students work alone</td>
</tr>
<tr>
<td>Focus is on concepts (e.g., homeostasis)</td>
<td>Focus is on facts (e.g., identification of bones and muscles)</td>
</tr>
<tr>
<td>Students process (think about) information and ask questions</td>
<td>Students listen and record information</td>
</tr>
<tr>
<td>Students are verbal, noisy, or even argumentative</td>
<td>Students are quiet and ask few questions</td>
</tr>
<tr>
<td>Instructor walks around the room while fielding and promoting questions</td>
<td>Instructor stays at the front of the room and talks (lectures) while showing PowerPoint slides</td>
</tr>
<tr>
<td>Student questions are frequently responded to with another question</td>
<td>Student questions are answered directly with a factual answer</td>
</tr>
<tr>
<td>Uncertainty and doubt are a good sign of learning</td>
<td>Uncertainty and doubt are signs of weakness</td>
</tr>
<tr>
<td>Role of the instructor is to promote cognitive disequilibrium (e.g., doubt and uncertainty) from which students are motivated to learn new information to resolve, e.g., solve, the conflict</td>
<td>Role of the instructor is to distribute (verbalize) what information is to be known</td>
</tr>
</tbody>
</table>

[Information was abstracted from Ref. 4.]
REFERENCES