FY11 Innovations in Teaching with Technology Awards:
Continuation Funding for the Development and Assessment
of Web-Based Student Generated Cause and Effect Diagrams
in Science Education

FY11 Innovations in Teaching with Technology Awards

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<th>Continuation Funding for the Development and Assessment of Web-Based Student Generated Cause and Effect Diagrams in Science Education</th>
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<td>Investigators:</td>
<td>Fred R. Dee</td>
</tr>
<tr>
<td>Org Unit:</td>
<td>Carver College of Medicine</td>
</tr>
<tr>
<td>Department(s):</td>
<td>Pathology</td>
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With this proposal we are requesting continuation funding for new enhancements to the software which will further improve the educational design and outcomes.

GOALS OF LAST YEAR'S PROPOSAL:
1. To positively impact student's understanding of cause and effect relationships in science. We aimed to accomplish this goal by creating, and extensively implementing and evaluating a novel computer-assisted scenario-based pathway diagramming instrument.
2. To improve efficiency and accessibility of teaching and learning in science education through computer assisted education.

DESCRIPTION OF THE DIAGRAMMING EXERCISE:

After reading a brief real-life or theoretical scenario, students are given an instructor generated list of 15-22 items that include etiologies, risk factors, intervening events, and observed phenomenon. Students drag items on to a computer stage and connect them with arrows to create a flow diagram that depicts the sequence of events (or pathways) leading to the observed phenomena. After the student creates and finalizes their diagram they receive automated feedback via instructor generated correct diagrams.

Potential educational settings for the software:
1. Independent and self-directed learning: Students create assigned diagrams outside of class and are then given electronic feedback.

2. Small group discussion: Students prepare diagrams for presentation and discussion in small group.

3. Self-paced education and assessment: Students engage assigned diagrams and must repeat the diagramming exercise until they achieve a minimum passing score; at which time they receive feedback. Completion of the assessment is monitored by the instructor. 

4) Team-based learning (TBL) exercises: Multiple teams of 6-8 students create diagrams in a large classroom, after which each team receives a score for their diagram; followed by a discussion amongst teams.

PROGRESS TO DATE:

With 2009 funding for this project we have created robust diagramming software and implemented diagramming exercises in several courses. Yet to be programmed into the database infrastructure are 1) functionality to electronically compute a correct score compared to the instructor’s solution diagram, and 2) the ability to capture data for reliability and discrimination indices. These should be completed later this fall with the 2009 funding.

The exercises may be accessed at: http://cts-lamp.its.uiowa.edu/pathwaydiagrams/login/ Committee members may log in to an exercise in one of the first two courses, briefly try out the navigation, and then click on finalize to see the instructor diagram.

To date we have implemented the diagramming exercises in four courses via a secure login mechanism. Biochemistry and Human Organ Systems-Physiology courses use setting 1). Medical Pathology I & II courses use setting 2). See evaluation results in the next section.

PROPOSED NEW ENHANCEMENTS:

Based on experience from implementations and evaluations in courses to date, we propose the following enhancements for increasing learning and efficiency, which were not envisioned in the original application:

1. Add intervention items to the list and direct students to connect these items to points in the pathway affected by that intervention.

2. Add a link from the instructor diagram to a concise narrative explaining key pathways. This would be used primarily for settings 1) and 3) to enhance independent learning from the diagrams.

3. Make correct arrow connections turn green when the student finalizes their diagram. This will make it easier for students to identify incorrect arrow connections.
on their diagram compared to the instructor diagram.

4. Pre-position some items from the scenario on the stage. This will further increase students efficiency and speed of diagramming.

5. Enhance efficiency of the authoring interface so instructors can electronically upload case content to the database.

6. Improve the esthetic appearance of the interface.

7. Develop a student tutorial using Panapto or other media recording software.

As outlined in our original proposal, the expected outcomes are that students who participate in these exercises will have a more in-depth understanding of cause and effect relationships in science, and be better able to explain how observed phenomenon develop from preceding events. An additional outcome is that students will acquire new knowledge about etiologies, risk factors, observed phenomenon and other entities as they prepare to create the diagrams. Active application of this knowledge in a diagramming exercise will in turn facilitate better retention and application. In small groups these diagrams can also be used to facilitate follow up discussion of:

1. Known interventions that can interrupt the causation depicted in the diagrams, to produce an altered outcome;

2. Gaps in our knowledge of causal relationships and interventions;

3. Hypotheses for investigation of these gaps to increase scientific knowledge.

Finally, we believe the web-based access will increase efficiency and accessibility of teaching and learning.

EVALUATIONS TO DATE:
Pilot implementation and evaluation using the prototype software was carried out in the fall of 2009 second year Medical Pathology I course and in the spring of 2010 first year Physiology course as proof of concept, and to acquire measures of student satisfaction of the navigation and potential for increased quality and efficiency of learning. In the Medical Pathology course case-based diagramming exercises were created for 8 of the 72 cases scenarios in the course and implemented in two case discussion groups of 8 students. Content development for both courses took ~90 minutes of faculty time per diagramming exercise.

PILOT RESULTS:
In the Physiology course diagramming exercises were implemented for optional independent learning using six existing case scenarios. End of Physiology course satisfaction questionnaire score was 4.55 on a 5 point scale (5=excellent; 4=very good; etc., n=76 of 140 students responding). Details of the results of the pilot evaluation in
the Pathology course can be seen in APPENDIX I following the estimate of costs narrative below.

Based on these encouraging pilots we implemented diagramming exercises in 31 cases in this fall s Medical Pathology I course (138 students). Small group facilitators were given the option to use the exercises in their groups of 8 students as required assignments, and ~80% of students report that their instructors have done so. Midterm satisfaction questionnaires were sent to students on Oct 11. As of this submission we have received 26 responses which are tabulated in APPENDIX II.

PLANNED EVALUATIONS:
At the end of the Medical Pathology I & II courses we plan to evaluate effectiveness of pathway diagrams in increasing learning and retention by selecting ~100 higher order mechanistic and integrative multiple-choice questions from a total of ~400 questions on course examinations. Examinations use ~90% repeat questions from year to year in a secure database, thus we will use the year before implementation as an historical control. No other course changes are planned.

Also at the end of the Medical Pathology courses we will compare student diagrams with instructor diagrams and calculate difficulty, discrimination, and reliability for the exercises (n= ~138 students, ~16 exercises each).

Independent study diagramming exercises will be more fully implemented and evaluated in the spring Physiology course. Also eight independent study exercises are being implemented and evaluated as a pilot this fall in the Biochemistry course (~140 students).

The results of the Medical Pathology course pilot were presented at the Group for Research in Pathology Education meeting in January 2010, in New Orleans, and one of the attending course directors (at Marshall University) is interested in implementing the exercises in their team based learning curriculum.

As mentioned above we have developed most of the programming envisioned in the original proposal. The programming to date has been carried out by Lance Bolton’s group. We are very pleased with the development work to date, however satisfaction questionnaires indicate that additional enhancements to the software would be very beneficial - see items 1) through 7) in the first section above.

These were not envisioned in the original proposal and thus the initial funding will not cover the cost of programming for them. Therefore we are requesting continuation funds to cover the cost of the proposed new programming.
What resources will you need?

Also future implementation in other course units and curricula would be facilitated by hiring student fellows to help faculty create content for exercises. Students were very instrumental in increasing faculty efficiency in developing the content for the diagramming exercises in the Biochemistry, Physiology and Medical Pathology courses.

EFFORTS TO ACQUIRE OUTSIDE FUNDS:
We submitted a proposal to the Department of Education’s (DOE) FIPSE Comprehensive Program in July 2010:
http://www2.ed.gov/programs/fipsecomp/index.html Initial communication from FIPSE indicates that we will NOT be one of the recipients.

If we can generate additional interest among undergraduate science educators, we will consider applying for a National Science Foundation grant. The NSF does not fund medical student educational projects, but is specifically interested in computer assisted instruction for undergraduate science teaching and learning.

Rough estimate of costs

A very rough minimum estimate for new programming, delivery support, and additional student help would be $30,000-40,000. If the committee is interested in continuing support of this project, more precise budgetary needs will be acquired from Lance Bolton.

APPENDIX 1

MEDICAL PATHOLOGY PILOT IMPLEMENTATION, FALL 2009 (n = 8 students, 8 cases)

1. Diagramming facilitates understanding of pathogenic and pathophysiologic mechanisms.
7 Strongly Agree
1 Agree
0 No opinion
0 Disagree
0 Strongly Disagree
2. Time and effort spent in creating the diagram before class
5 Very Efficient
1 Efficient
2 Acceptable
0 Excessive
0 Very Excessive
3. Average time per exercise exclusive of learning the content of the case ~15 min.

APPENDIX II
MEDICAL PATHOLOGY IMPLEMENTATION, FALL 2010 (n= 31 cases, 26 student evaluations returned to date)

1. Please rate the effectiveness of the diagrams in facilitating an understanding of the pathogenesis and pathophysiology operating in the cases.
   13 Excellent
   8 Good
   3 Fair
   0 Poor

Selected comments on how the diagrams enhance learning:

- For visual learners, the diagram provides needed structure to the various factors involved in the pathophysiology of a given disease.
- The diagrams force you to really consider the stepwise progression of a disease, which was particularly helpful for the neoplasm cases.
- Good to think through the entire process and mechanisms rather than just focus on the end-point of the disease.
- It's really helpful to see the big picture and understand how things progress.
- It's helpful if you're totally lost with the case as a starting point.
- Illustrate the importance of process in yielding clinical symptoms or findings.
- They are good for helping to visualize cause/effect, relationship, confounding factors, symptom list, and abnormal test results.
- When going through cases before class, the diagrams help to guide my thought process.
- They are a helpful place to start when I don't know where to begin on a case.
- Help with complicated cases when there are lots of factors.
- They give you a method to integrate all the aspects of a given disease and tie together components of the disease that you maybe didn't think about before doing the diagram. I like them.
- Good to figure out what caused what and guide you through the case.
- The diagrams enable the student to follow how pathology is occurring and why the microscopic/gross specimens look the way they do.
- They help emphasize key concepts and are also good for reviewing.

Suggestions for improvement (unedited):

- This is a great start, though the actual functioning/cosmetics of the program could be improved. For example, it can be quite difficult to delete the arrows at times due to their thin nature.
- Going through and trying to piece the diagram components are good; however, I think it would add more to correct our thinking if we could see the instructor diagram right after finalizing our individual diagram.
Many times items of the diagram can be in multiple places that are not closely related.
If instead of just words, there were also pictures that would be super cool.

2. The time and effort spent in creating my assigned computer diagram (exclusive of learning the subject matter and associations) was:
10 very efficient
10 efficient
3 acceptable
0 excessive

Comments (unedited):
- The preparation to be able to do the diagrams correctly takes a long time.
- The pathway diagrams actually help me get started working through the case.
- Robbins text greatly helps with these diagrams! Diagrams are a less wordy form of describing the pathogenesis.
- Well worth the time and made the cases easier.
- Some are too detailed, it is difficult to find such precise pathogenesis; the exercise becomes an excessive use of time.