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Non-science majors gain valuable insight studying clinical trials literature: an evidence-based medicine library assignment

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Russell, Janet S., Lucy Martin, Dara Curtin, Sara Penhale, and Nathan A. Trueblood. Non-science majors gain valuable insight studying clinical trials literature: an evidence-based medicine library assignment. *Adv Physiol Educ* 28: 188–194, 2004; doi:10.1152/advan.00029.2003.—When faced with a diagnosis, it is empowering to be able to assess the evidence of treatment effectiveness and safety. To teach this skill to non-science majors, we assigned the "Responsible Patienthood Project" (RPP). For the RPP, students studied an array of disease and treatment literature: the final product of their work was a poster presentation, in which they did an in-depth analysis of one primary article, thus encouraging critical evaluation of experimental design, methods, and conclusions. Post-RPP, there was a 35% decrease in the student perception that they would unquestioningly accept a recommended treatment for a hypothetical diagnosis, and a 40% increase in the perception that they would consult a combination of resources, including primary articles. We recommend this project based on our results that suggest *1*) non-science majors are able to successfully access and assess primary scientific literature, *2*) students felt empowered by the RPP, and *3*) skills in information gathering, via library instruction, may serve as a particularly helpful lifelong learning tool.

undergraduate student; general education; diagnosis; clinical research; lifelong learning

LIKE MANY UNDERGRADUATE programs, Earlham College includes in its goals for general education the "aim to graduate students who possess . . . *a desire and the skills to be a lifelong learner* (3)." A practical example of lifelong learning may be seen in response to a medical diagnosis and the recommended treatment, wherein "responsible patients" do their "homework" on the disease and prescribed treatment. Science majors are often trained to find and use primary scientific literature and this may enable them to feel comfortable accessing and assessing scientific literature with regard to diseases and treatments. If students are trained in the task of critically evaluating the primary clinical literature to assess the efficacy of a treatment, it follows that this training may be valuable at multiple times in their life and facilitate their ability to learn about diseases and treatments throughout life. It is virtually inevitable, however, that every college graduate (science majors and non-majors alike) will ultimately develop a condition or ailment in his or her lifetime. Accordingly, we feel it is valuable to enable non-science majors to feel comfortable accessing (and beginning to assess) primary scientific literature.

In our non-majors general education course, Human Biology, we have been capitalizing on a student's interest in human disease and disease treatments for over 20 years with a project called the "Responsible Patienthood Project" (RPP). The RPP has evolved over the years from the use of abstracts of medical articles in lieu of whole articles to the use of CD-ROMs of Medline to access the latest research (12). This study describes the most recent evolution of the RPP at Earlham College, in which students focus their attention on accessing, reading, assessing, and presenting original clinical trials to be well-informed "hypothetical patients."

METHODS

The course. Human biology is a general education-fulfilling survey course about human health designed for non-majors. Labs consist of basic exercises in anatomy and physiology, and some cooperative group research projects. Enrollment ranges from 30 to 70, and students range from first year to graduating seniors.

The assignment. In RPP, students evaluate the efficacy and safety of a treatment regimen based on medical evidence. The final product of the RPP assignment is a poster presentation. A brief description of the assignment and its requirements is given in Fig. 1.

After an introduction to the purposes of the RPP, students pick a condition/treatment pair that they will study (Fig. 2). Students are encouraged to work in pairs, but some work in groups of three and some work alone. The science librarian and course instructor then guide the class through the web pages constructed for the RPP (http://www.earlham.edu/~biol/nathan/humanbio/humanassign.html).

One of the requirements of the project is that students use a total of nine sources of information, of which four must be primary, original research papers. Students choose one of these primary articles as their in-focus paper and devote approximately half their poster presentation to it. The intent of the in-focus paper is to help students understand experimental design and presentation of original data. Furthermore, with the increased emphasis on one particular clinical trial paper, we hope students will more critically evaluate the strengths of the research and the suitability of the conclusions made. For instance, instead of basing their evaluation of drug safety and efficacy on literature provided by the manufacturer of the drug, we require that they look at the original research design and results on which the manufacturer has based their advertised claims.

Acclimation to information resources. After the introduction to the assignment, the choice of a disease/treatment combination and a group, and the introduction to the assignment web page, the class receives instruction on the paper and electronic information resources in the library. As part of the library instruction, there is an initial hands-on "information scavenger hunt" exercise in which students gain some guided experience with a variety of library tools. Students are then given class time to get started on their group's disease/treatment combination. Beyond this initial structured class time, the students are "on their own" for completion of the assignment.

The poster presentation. The final product of the RPP assignment is a poster presentation. Each student, or pair of students, gives a formal poster presentation to the rest of the class, followed by a period for questions and answers and open discussion. More information about the requirements for the poster can be found in Fig. 1.

The assessment tool(s). To determine whether the RPP moved students closer to our goal of becoming "responsible patients," and by extension lifelong learners, we designed and implemented a pre- and post-RPP assessment tool (Fig. 3). As can be seen in the question-

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Responsible Patienthood Project
Assignment Description

Imagine that you (or a friend or family member) have been diagnosed with one of the following conditions, and that the accompanying treatment has been prescribed or suggested: Diagnosed Conditions and Prescribed Treatments
As a **responsible patient**, you seek to investigate the nature of the condition and the effectiveness of the treatment using this guide to resources in the Wildman Science Library: Resources on Medical Topics

Prepare a Poster Presentation that includes:

1. a description of the condition and its symptoms.
2. the etiology (cause) of the condition.
3. the prognosis (outcome) of the condition.
4. a summary of the scientific evidence for the effectiveness of the prescribed or suggested treatment, its side effects and contraindications (conditions under which it should not be used). You do not need to explain the mode of action of the treatment.
5. a 'focus' on *one* particular research paper. For this *'In-Focus'* paper, you will present a summary that describes a) the study design, b) the major end-points/variable measured, c) the major findings (including 2 graphs or tables from the focus paper) of the study, and d) the major conclusions of the study.
6. if you do not recommend the prescribed or suggested treatment, briefly note an alternative treatment, including some evidence that it may be a better alternative
7. use a minimum of 9 sources, total, for the project, including 4 total primary research articles (to include the 'In-Focus' paper and at least 3 others). In addition to the 4 primary literature journal articles, you may use secondary review articles, abstracts of journal articles, reference texts, brochures or websites to reach your total requirement of 9 total sources.
8. cite your sources using the name/date method and provide a Literature Cited section at the end of your poster. For details, see How to Cite Sources.

Fig. 1. The Responsible Patienthood Project (RPP) assignment description. For further information and links associated with the assignment, see the web link in METHODS.

naire, the goal of this assessment strategy was to determine whether the student's responses to a "real-world-like" situation might be altered by the RPP. The situation or scenario used in the questionnaire was taken partly from the real-life experiences of a family member of one of the authors of this paper but was written from the perspective of the individual student completing the questionnaire to put the student "into the situation."

The students were asked to categorize the likelihood of their adopting a range of nine hypothetical responses to the diagnosis/treatment involved (Fig. 3). The five choices ranged from "Definitely not" to "Definitely would" and these choices were later given a numerical score from 1 to 5 by a student researcher. The numerical scores for each of the nine possibilities (Fig. 3) made by all of the students were compared between pre- and post-RPP by a paired *t*-test (SPSS version 11.0).

In addition to this pre- and post-assessment tool, students were encouraged to provide further comments or suggestions after completion of the RPP. Some selected comments have been provided in Fig. 5.

Finally, we counted the number of primary literature sources actually used by each student group. Given that students were explicitly required to use four original research papers overall in preparing their posters, we suspected that non-science majors would not use any more than the required number. The results of this assessment are discussed below.

RESULTS

Survey/questionnaire. On the basis of the pre- and post-RPP assessment, students were 32% less likely to "agree without question" to the treatment suggested by the physician in the scenario after completing the RPP. Furthermore, the students' post-RPP were 40% more likely to use a combination of primary and other literature sources to become more knowledgeable about the condition and treatment (Fig. 4, *A* and *B*). None of the other survey questions revealed significant differences between pre- and post-assessments.

Student comments. Students generally gave positive comments about the RPP (see Fig. 5). The students felt they had gained practical skills with the project and they generally understood the long-term usefulness of the RPP training. Furthermore, there were several comments from students about their enjoyment of going "in-depth" with a disease instead of sitting through a lecture-based survey of all of the diseases. Another common thread in student comments was an increased sense of confidence in looking information up for themselves.

The only negative comments about the RPP were in the organization of the Oral Poster Presentation. Specifically, we opted to devote 2.5 lecture meetings to running through all of the poster presentations back to back. Students perceived this as too much concentrated time on the RPP, and too little on lecture. Students suggested instead spreading the oral poster presentations over the semester, so that there might only be one or two presentations per day.

Student performance. As an indication of the capability of non-science majors to access and interpret primary scientific literature, grades earned for this assignment were generally quite high, with an average grade of 86 ± 10% (range: 51–99%). The average RPP grade was ~10% higher than the average exam grade for the class, a finding consistent with a generally strong performance on the RPP. There was no relationship between exam performance and RPP performance ($R^2 = 0.10$), suggesting that some students who do not perform well on examinations were able to excel at the RPP (and also

Responsible Patienthood Project: Diagnosed Conditions and Prescribed Treatments

- AIDS: protease inhibitors
- Alcoholism: disulfiram
- Alopecia (balding): minoxidil (Rogaine)
- Alopecia: propecia
- Alzheimer's : estrogen
- Colon cancer: monoclonal antibodies
- Angina : aspirin
- Asthma : albuterol
- Attention deficit disorder: methylphenidate
- Bipolar disorder (manic depression): lithium
- Breast neoplasms (cancer): lumpectomy
- Breast neoplasms (cancer): tamoxifen
- Breast neoplasms (cancer): Herceptin
- Bulimia: psychotherapy
- Candidiasis (vaginal yeast infection): fluconazole
- Cholethiasis (gallstones): lithotripsy
- Chronic fatigue syndrome: magnesium
- Common cold: *Echinacea purpurea*
- Coronary disease: laser
- Coronary heart disease: antioxidants
- Depression: fluoxetine (Prozac*)
- Depression: St. John's Wort
- Depression: electroshock therapy
- Diabetes (non-insulin dependent): exercise
- Diabetes (non-insulin dependent): troglotizone
- Dyslipidemia: niacin
- Epilepsy: valproic acid
- Gastric (stomach) acid: omeprazole
- Genital herpes: acyclovir
- Heart failure: enalapril
- Heart failure: beta-blocker
- Heart Failure: LVAD (left ventricular assist device)
- Hypercholesterolemia: lovastatin or oat bran
- Impotence : Viagra
- Insomnial: melatonin
- Leprosy : thalidomide
- Malaria preventative: mefloquine or chloroquine
- Menopause : estradiol
- Migraine: sumatriptan
- Obsessive compulsive disorder: clomipramine
- Osteoporosis : calcium
- Pain: morphine
- Panic disorders: imipramine
- Parkinson disease: levodopa
- Premenstrual syndrome: progesterone
- Schizophrenia: haloperidol
- Smoking cessation: nicotine
- Ulcer: remove *Helicobacter pylori* with metronidazole
- Urinary incontinence: physical therapy
- Vitiligo: PUVA
- Weight control: phenylpropanolamine
- Weight control: surgical reduction of stomach size

Fig. 2. The list of conditions/treatment combinations from which students selected. On the basis of library resources, these conditions/treatments have worked well in the past.

the corollary). Indeed, the student with the greatest RPP grade-exam grade difference (31%) had an exam average of ~65%, yet earned top marks for the RPP. This suggests that the RPP may be able to capture the interests of some students who otherwise do not fully apply themselves in traditional, exam-based courses. The lack of correlation between exam scores and RPP grades also reflects the inability of some students who normally excel at examinations to transfer their skills to the RPP.

Number of primary sources used. One of the requirements of the RPP was to use at least nine information sources, of which four needed to be primary literature (see METHODS). Other acceptable sources included web pages, review articles, reference texts, books, brochures, etc. Most of the students (~80%) used more than the required number of primary journal articles, and web sources were only 38% of the five "other sources."

DISCUSSION

The RPP assignment presented here is particularly helpful at instilling confidence in non-science majors for finding and applying specific information from primary research articles. Furthermore, this assignment may impact student response to medical diagnoses in the future by helping them to be responsible patients/lifelong learners.

The RPP assignment capitalizes on the general interest in health–one's own health and the health of loved ones are topics of great interest. A 1995 survey by Miller (8) indicated that 70% of Americans found medical news interesting, while a

The scenario- You keep feeling breathless, even with activities of daily living (you haven't felt up for exercise for several months)…so you go the major/modern hospital in town. You see a "new to you" but very well qualified physician (she's a Harvard Med School grad). She performs an ultrasound of your heart, and says that you have an "atrial septal defect" (a 1.5 cm hole connecting your right and left atria, it shouldn't be there and is causing all of your symptoms!). She explains that the treatment options include

1) *Open-heart surgery (which requires risky cardiopulmonary bypass and 4 or 5 months to recover), or*
2) *Insertion of a "star-occluder" (device that is inserted into a vein in your leg, and it is fed up into the heart through the vein and is then positioned over the hole fixing/closing the hole permanently, all remotely, without opening your chest and without cardiopulmonary bypass and only requires ~3 days of recovery).*

She suggests that you get the open heart surgery because the hole is pretty big for a star occluder and the open heart surgery is the "gold-standard" traditional repair…and more common, too. She then excuses herself to deal with a trauma that is arriving at the hospital…

How likely are you to do the following?

1) *Use web-based resources (e.g. webMD)* ***only*** *to help you understand your condition and treatment options:*
2) *Use primary scientific literature (e.g. a clinical trial)* ***only*** *to help you understand your condition and treatment options:*
3) *Use secondary scientific literature (e.g. a review article)* ***only*** *to help you understand your condition and treatment options:*
4) *Use a combination of scientific literature (primary & secondary) BUT* ***NOT*** *web-based sources to help you understand your condition and treatment options:*
5) *Use a combination of scientific literature (primary & secondary)* ***AND*** *web-based sources to help you understand your condition and treatment options:*
6) *You agree to the open heart surgery and DON'T do any web or literature checks:*
7) *Do a "spot check" of the web (e.g. a quick look at 2 or 3 of the web pages that come up after a web/Google search):*
8) *Do a "spot check" of the scientific literature (e.g. look at a couple of abstracts but no more than that):*
9) *You set up an appointment to ask more questions of a physician (either the same one or a different one):*

For each numbered response (above), students indicated a value (1 through 5).
1 = Definitely not; 2 = Probably not; 3 = Maybe; 4 = Probably would; 5 = Definitely would

Fig. 3. An example of the student survey that was given pre- and post-RPP.

survey at a liberal arts institution not unlike Earlham (2), indicated 68% of non-science majors had a high level of interest in health and human disease. Although we have not conducted such a survey of our own students, our experience with the RPP and other projects suggests that Earlham students are similarly intrigued. Perhaps students are motivated by the near certainty that they or people they know and love will fall out of health, be diagnosed with an ailment, and be prescribed a treatment, and will thus want to lay a foundation of understanding with which to meet this occasion, or perhaps act as advocates by asking, "is this the only/best treatment available," or simply, are curious.

Regardless of the reason(s) for interest in the topic of human health, it is unlikely that students are prepared to meet the challenge of gathering and critically analyzing health information. Only one in nine Americans, and only 20% of college graduates (8), consider themselves to be well informed about science and technology. If the desire is to be a health advocate the picture is dim as well. About one-half of college graduates in the Miller survey (8) said they felt they could make sound decisions about scientific results reported in the media. Curiously, the Drury undergraduate survey (2) showed that though only 48% of non-science majors feel they have a grasp of the *process* of making discoveries in science, more than 80% feel they can grasp the scientific findings and supporting statistical data reported by the media. This may hint at the differing abilities required to comprehend a popular account versus a primary literature account of a scientific discovery.

The current trends in both the information gathering practices of young adults (7) and direct-to-consumer drug advertising (6), add their own layers of difficulty for anyone trying to be a smart health consumer and/or advocate. Students are increasingly comfortable with web sources of information, and, given the option, might choose to use web pages exclusively rather than blending the web with other possible sources of medical information including primary sources (7). Interest-

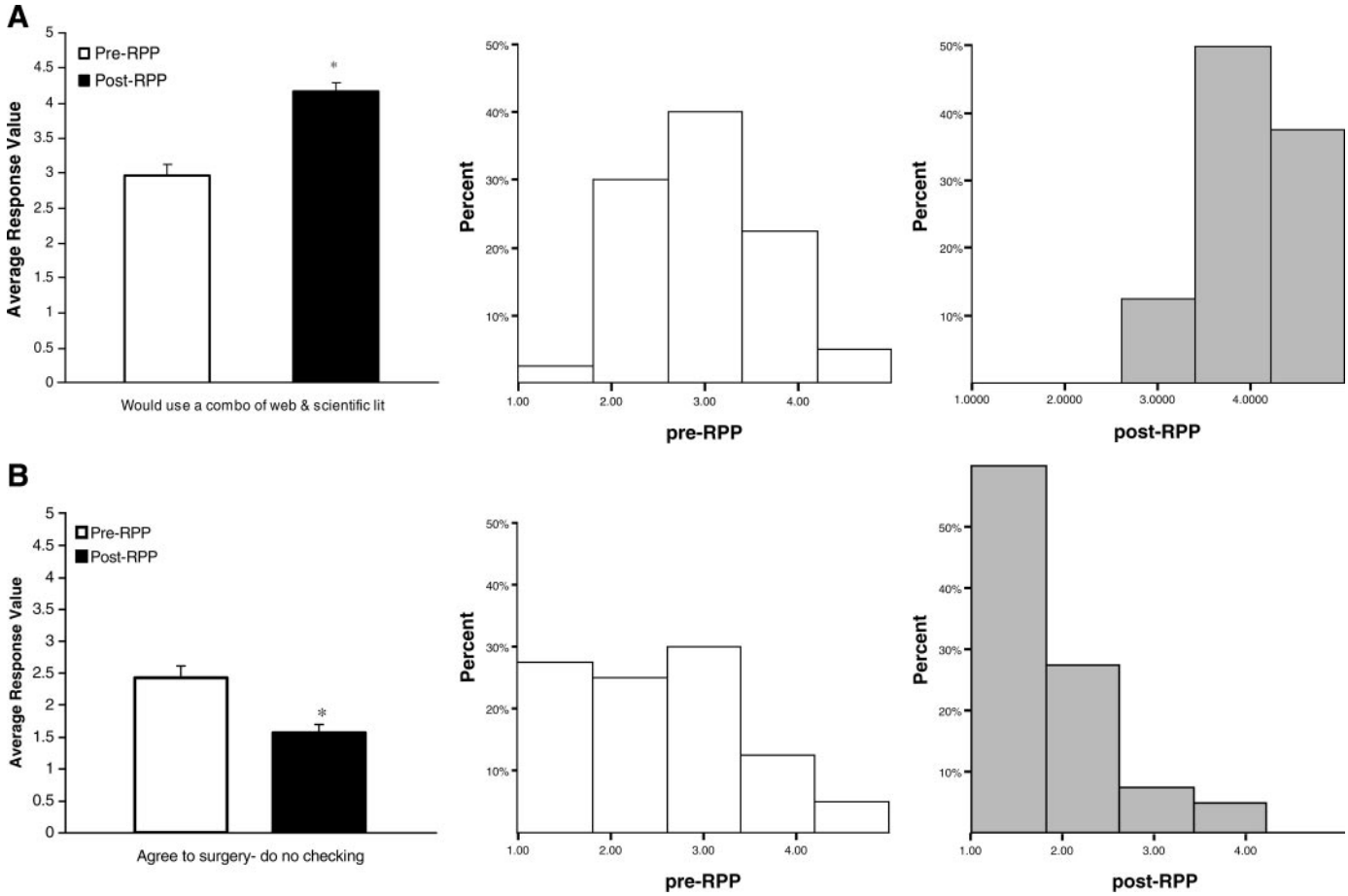

Fig. 4. Comparison of response values in the RPP evaluation survey administered before and after the RPP assignment. Higher response values indicate agreement with the response option and are based on a scale from 1 to 5, where 5 indicates "definitely would" and 1 indicates "definitely would not" (see METHODS and Fig. 3). *A*: responses to the option "Use a combination of scientific literature (primary and secondary) and web-based sources to help you understand your condition and treatment options." Histogram of student response values pre- (*middle*) and post-RPP (*right*). $*P < 0.05$, pre-RPP vs. post-RPP. *B*: responses to the option "You agree to the open heart surgery and don't do any web or literature checks." Histogram of student response values pre- (*middle*) and post-RPP (*right*). $*P < 0.05$, pre-RPP vs. post-RPP.

ingly, the Pew Internet and American Life Project has found that more than half of those who recently conducted health searches online did so on behalf of someone else, reinforcing the "caregiver" training of the RPP (13). This Pew Internet and American Life Project further found that the percent of Internet users seeking medical/health information online has been increasing recently (an increase from 62% to 80% last year) and that the most common task is researching specific diseases or medical problems, followed by researching specific treatments or procedures (13). Since the RPP trains students to use primary literature, in addition to other sources, for these same and increasingly common tasks, it follows that the RPP may be enabling our students to move "beyond" the summaries, interpretations and distillations of web page information, and into the original evidence found in the primary scientific literature.

Without the type of guided experience that projects like the RPP offer in accessing scientific literature, students might not know (beyond web sources) what information tools are available. More importantly, they likely would not know how to evaluate the safety and efficacy of the information espoused in *any* of these sources. Given the number of pharmaceutical, surgical, and nontraditional options for most afflictions, and the aggressive marketing campaigns associated with some of them, it is not always clear which treatment regimen is most effective, or safest, or simply the most current and well funded. Along these lines, students are encouraged to compare the efficacy and safety of the treatment studied in their in-focus article with other treatment choices for their RPP poster presentation.

With this library-based research project, we hoped to facilitate student use of medical evidence in their current course and, perhaps more importantly, in their future personal health decisions. Indeed, our results indicate that the RPP enabled our students to find, assess, and base health decisions on medical evidence, including that in primary literature. Moreover, the RPP was pertinent to the course in terms of the biology content encountered, and it engaged students in the activities of scientists in terms of learning how to interpret graphs and in critically evaluating the literature.

One of the successes of the RPP was the verification that primary literature can serve as a valuable learning resource for non-science majors. The value of using primary literature in undergraduate science programs has been convincingly shown (5). But this experience is often reserved for upper-level

Student Comments on the RPP

I liked learning about the disease we studied—I really feel like I KNOW it. And I liked learning how to find info about treatment—I feel very capable and better prepared

I think it showed me that there are a lot of different treatments for one thing and it's a good idea not to just take the advice of the doctor, I didn't think about that before

I learned a lot about a "disease" which I am having to deal with

It familiarized me with medical journals and places I can go to find out about diseases and treatments. I learned new treatments and the effectiveness of them for specific symptoms

I liked that it taught me how to find the needed tools to make my own decision about my treatment or health.

Getting in-depth on a health concern that is relevant to our lives was worthwhile

It challenged my trust in on-line resources

It was applicable to life—I can see how I'd use the research skills I learned

It is important to know what resources are available in case you are sick. It is important to be able to understand how to interpret research

It was good to hear about a variety of different diseases and potential treatments. It was very valuable to learn how to find and understand scientific writing on treatments for disease (they always seem inaccessible previously)

It helped me learn ways to look up things by using tools I hadn't thought of. I actually learned something useful.

I liked having to use and understand primary sources. It made them more accessible

It taught us that you can't always trust the common treatment

Fig. 5. Human Biology class student comments on the RPP.

classes within science majors. With only rare exceptions (11) are *non-majors* exposed to scientific literature, experimental design, or clinical trials, let alone expected to use them. But, from our course and its evaluation, we conclude that non-science majors are capable of finding, interpreting, and critiquing primary scientific literature. The basis for this conclusion is that the students were generally able to speak clearly and with accuracy about the experimental design and details of the results in their in-focus paper. In fact, through their oral presentation of the research and ensuing discussions, students generally performed well in answering questions about the adequacy of control/placebo groups, and were able to give reasoned, justified conclusions on the quality of the research in their in-focus paper. Finally, as described in RESULTS, the grades earned on the assignment were generally high, relative to other assignments, and were consistent with strong performance.

From the standpoint of reforming science education, the RPP works as well. By now many reports (9, 10) have been issued suggesting that students learn more if they feel connected to the material and understand that science is not a set of distilled facts, but is instead a process that is still in process and which is meaningful and relevant in their lives. Even if students realize that science can deliver good things (8), they likely do not grasp the process leading up to that delivery, thus making it even harder to see any possible way they might

intercede, manipulate, or otherwise apply the product of science. With the RPP, because we are giving students the chance to shift their subject position from student (or later from patient), to researcher and presenter, they engage with science on a different level and even engage in a "teaching to learn" position (1). Such techniques are often used to increase interest in a topic but here it can help shift the learning to the student and also to shield them from emotional overinvolvement (i.e., if they were actually making health decisions). Prior research has shown that, besides helping students to master a topic, teaching the topic to others and engaging it in a "real world" sort of way increases student competence and confidence (1).

Moreover, the RPP is surely an active form of learning, because students are responsible for choosing a disease/treatment, collecting and analyzing appropriate literature, culling that literature down to one piece they find to be exemplary (for the in-focus paper), and using that piece as the basis of their poster, in which they communicate to an audience their sense of this disease and its treatment options. In an article outlining five principles of making science teaching relevant, Art Hobson said, "Nonscientists have little need for scientific techniques, but an urgent need to integrate science into their lives" (4). To this end, Hobson lists "make it modern" and "make it social" as two of the five key principles (4). We feel that the RPP is successful in these two principles. In fact, during their oral poster presentations, many students divulged information from their personal lives about loved ones with the diseases they chose to work on in their RPPs. This helped to make the process and the information more meaningful to themselves and to the student audience and demonstrated that learning tied to experience can have added power (4). Furthermore, almost all of the oral poster presentations were followed by numerous follow-up questions and an exchange of personal stories from the student audience, making for a lively social interaction, which added a "common community" feel to the experience.

It is possible that a non-RPP class activity may have influenced the success of the RPP. Specifically, the same class that did the RPP had a regular laboratory activity at a local retirement center. For this lab activity, students were paired up with an elderly individual for whom they performed some basic health measures (peak expiratory flow rate, systolic and diastolic blood pressure, heart rate, and percentage of body fat). They also socialized and did aerobic exercises with them. It is possible that some of the students gained a heightened awareness of the fragility of health, and therefore became more personally involved in the RPP. Interestingly, very few of the disease/treatment combinations chosen by the students were specifically related to the aging process or affected the individuals with whom they were paired.

In summary, we have found that the RPP, which asks students to act as "hypothetical patients" and focus their attention on reading, assessing, and presenting original clinical trials, brings about positive changes in our human biology students. These non-science majors were able to successfully access and assess primary scientific literature for evidence of treatment efficacy and safety, and, as a result, felt empowered by the RPP. The instruction in library resources that underpins this project may serve as the basis for important lifelong learning.

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