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Adding value to a graduate physiology seminar by focusing on public communication skills

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A MAJOR GOAL of graduate education is the development of students as "stewards of the discipline," scholars who can create and preserve knowledge and responsibly translate it through writing, teaching, and practical applications (5). These qualities are consistent with the American Physiological Society's list of professional skills for physiologists and trainees (3). Key competencies on this list include building core biomedical knowledge, research/analytical abilities, and communication skills. By default, core knowledge and research aptitude are a central focus of most graduate physiology programs. As a result, there is significant interest in teaching strategies like active and problem-based learning (PBL) that enhance the development of these competencies (9, 14). However, communication skills often receive less emphasis, leaving many graduate students underequipped to effectively share their knowledge with the wider community (7, 13).

Most opportunities graduate students do have to learn and practice communication skills involve scientific audiences. However, for most students, effective public communication skills may be just as important (7, 13). Students planning to pursue academic careers, for example, will be expected to contribute to the research missions of their institutions, most of which emphasize the dissemination of scientific knowledge for the good of society. Indeed, public outreach is often a key component of institutional service expectations. This requires scientists to clearly and succinctly explain complex ideas to nonexpert audiences. Successful scientists also need these skills to effectively explain their work to peers in other disciplines (e.g., as guest lecturers in other departments) or staff officials at the National Institutes of Health or other health/research organizations, and to describe the importance of their research to nonexperts in industry, foundations, and potential donor/philanthropic groups to obtain funding. Similarly, and perhaps even more importantly, a significant percentage of graduate students studying physiology are bound for nonresearch careers in health care, public health, teaching, industry, and other fields. Without a doubt, these students will need to clearly and effectively explain science to patients, students, colleagues, and other nonscientific groups. Nevertheless, most graduate students receive little or no training in communicating with such general audiences.

A general lack of training in public communication skills is a particular concern in the context of key public health problems, pressing issues that require research attention and broader public action (2). One such issue is population aging. In the next few decades, the population of older adults is projected to more than double, and we are currently unprepared for the health care and societal burdens this change will bring (11). This will be a high priority issue for the next generation of biomedical researchers, care providers, and policy makers (today's graduate students), and they will need the proper core knowledge, research training, and communication skills to address it. With this in mind, we set out to design a graduate course on the physiology of aging focused on building core knowledge/aptitude and developing public communication skills.

Approach

Our department offers *The Physiology of Aging* as a graduate seminar every other year. This 3-credit hour, ~20-student course is traditionally structured as a series of lectures by experts in different areas of research on physiology and aging. The major focus is understanding how physiological functions change with age and what (if any) interventions may prevent or improve these changes. We decided to revise the original course to also include a focus on public communication. To do so, we developed a semester-long PBL project aimed at identifying timely issues related to the physiology of aging, reviewing the literature on these issues, and creating presentations and written summaries for a nonscientific audience. To enhance the project's relevance and provide students with a concrete goal, we planned to build a website to make the students' work available to the public at the end of the semester. The idea for a website stemmed from our own laboratory's recent efforts to communicate evidence-based knowledge about healthy aging practices to the general public (healthyagingproject.org). We restructured the course to include both this project and the lecture series, thereby maintaining a focus on core knowledge while exposing students to a real world example of public communication.

We formatted the course so that we could emphasize both core knowledge and the PBL/communication project during each class session. The class met once each week for 2.5 h, and we devoted one-half of each session to expert lectures on topics such as the basic biology of aging, energy balance, sleep, bone physiology, cognitive function, neurodegenerative diseases, and many others. We assigned readings in advance of each lecture, and students were expected to participate in a spirited question and answer period with each presenter.

The other half of each session was devoted to the PBL/communication project. For this project, we asked students to *1*) practice communicating with a nonscientific audience by writing weekly summaries of new/publicized research on aging (short individual assignments that could become brief "news posts" on the website) and *2*) develop their ability to interpret and communicate science for a general audience by working in teams to review, evaluate, and summarize the quality of liter-

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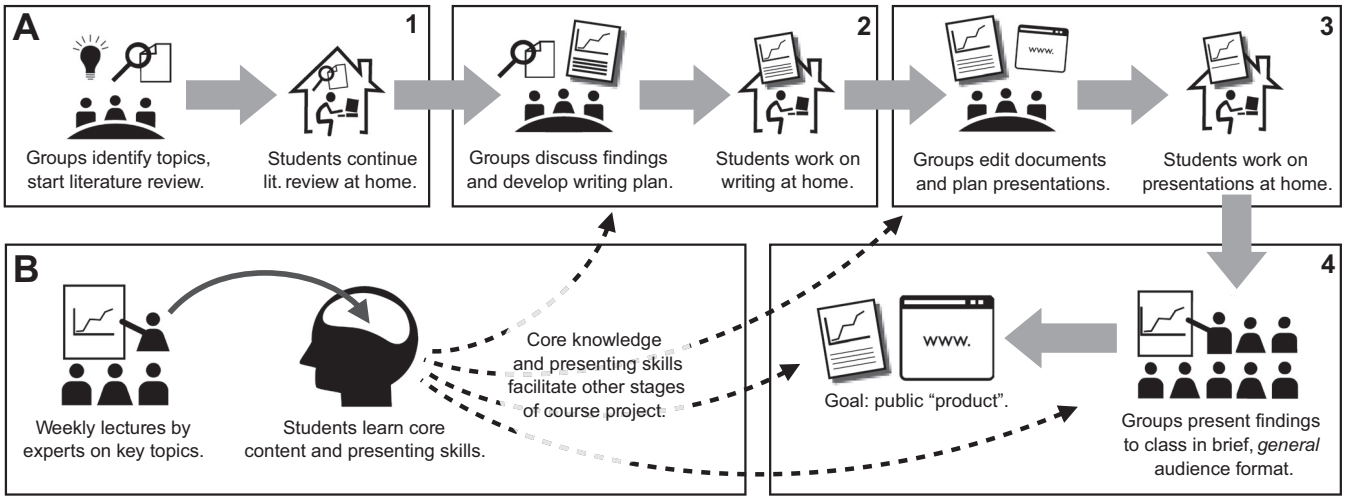

Fig. 1. General format of the course. *A*: the four-stage group project aimed at identifying key topics, reviewing the literature, and summarizing findings in public-friendly (website-appropriate) documents and presentations. *B*: weekly expert (faculty) lectures to build core knowledge and demonstrate skills, both of which facilitated the group project.

ature on different "hot topics" in healthy aging (factors or interventions with the potential to improve physiological function in older adults). We chose to have students work in small groups, because team-based learning has been shown to promote collaborative problem solving in PBL settings (1). Each group developed both written summaries and brief PowerPoint presentations targeted at a nonscientific audience, all of which could be used as content for a website on healthy aging. To guide students toward this goal, we provided students with templates/examples of each assignment type. In addition, at the start of the semester, we invited a science writer from our university's public relations department to speak to the class about general strategies for writing and communicating with the public and included a lecture on the skills necessary to conduct a thorough literature review.

To determine the feasibility of this PBL project, we conducted a "pilot trial." Before the start of the semester, we (the instructors) went through the process of identifying a topic, reviewing the literature, evaluating the quality of the evidence, and preparing brief written summaries and presentations. Based on our experience, we set up the project as a module that students would repeat three times throughout the semester. Each module consisted of the following four sessions:

1. PBL groups meet (3–4 students/group each) to identify topic and conduct an initial literature review. Students continue the literature review at home.
2. Groups reconvene, evaluate the literature review, and develop a plan for creating summaries. Students work on individual components of summaries at home.
3. Groups reconvene, discuss/edit summaries, and plan for final documents and presentations. Students work on final summaries and presentations at home.
4. All groups deliver brief presentations summarizing findings for the entire class. Groups turn in final written summaries.

This project format was complemented by the weekly lectures, which, in addition to promoting core biomedical knowledge, also served as opportunities for students to see how leading experts convey their science to a diverse, nonexpert audience (Fig. 1).

To start students off on the right foot, we developed a list of tractable topics for them to choose from (Table 1). We asked each PBL group to select a physiological function and related intervention from this list for the first iteration of the project and encouraged them to use the list as a guide thereafter. Once groups had identified a topic, they determined their own specific action plans; some chose to divide the literature review into smaller components, whereas others decided to have each member research the same things and then compared notes. Most groups divided the writing and presentation/slide-building tasks, and they met outside of class to synthesize their work into final products. We graded each of these based on accuracy and comprehensiveness as well as clarity and "public friendliness" so that students could improve those features of their work from one project cycle to the next.

Table 1. *Examples of suggested topics for the problem-based learning literature review project*

Factors/Interventions	Physiological Functions
Physical activity	Neuromuscular
Aerobic exercise	Aerobic capacity
Resistance exercise	Strength
Daily physical activity	Balance
Nutrition	Coordination
Calorie intake	Cognitive
Diet composition	Executive function
Hydration	Memory
Pharmacological agents	Processing speed
Anti-inflammatories	Attention
Pharmaceutical drugs	Bone
Dietary supplements	Bone density
Antioxidants	Metabolism
Calcium	Metabolic rate
B vitamins	Body composition
Vitamin D	Insulin/glucose homeostasis
Glucosamine	Hepatic
Omega-3 fish oils	Circadian rhythm
Nutraceuticals	Cardiovascular
Resveratrol	Blood pressure
Curcumin	Cardiac
Nitrate/nitrite	Vascular
etc.	etc.

Outcomes

Topics and products. Students' weekly summaries of new/publicized research on aging ("news posts") served as basic skills practice. Topics ranged from summaries of original research articles in scientific journals to commentaries on recent newspaper or website pieces highlighting issues related to aging. We graded these quickly each week, giving students brief feedback on readability and appropriateness for nonscientific audiences. This also helped to prepare students for the PBL project. Students worked on preapproved topics for the first project cycle. After that, they were more adept at identifying timely issues related to the physiology of aging and framing manageable questions for subsequent project cycles. Examples of topics identified by students included:

- The efficacy of probiotics for improving mood/well-being in older adults
- Evidence in support of antioxidants for enhancing/preserving motor function with age
- The influence of the Mediterranean diet on age-related changes in cognitive function
- The impact of anti-inflammatories on glucose-insulin homeostasis with aging

Efficacy and student feedback. At end of the semester, we circulated an optional and anonymous survey asking students about their experience in the course. Because this was an exploratory project, the purpose of the survey was simply to determine if students felt that the course format and content were valuable. Therefore, we designed the survey to focus on students' satisfaction with specific aspects of the course and used "traditionally designed courses" as a reference point when appropriate, a common approach when piloting a new course (1, 4). Because the survey was optional/anonymous and not systematically designed as research, it was determined to be exempt from Institutional Review Board oversight by the University of Colorado Boulder. It contained seven Likert scale-based questions asking students either to rate specific aspects of the course or to compare the course with other traditional graduate physiology courses they had taken as well as three open-response questions asking students about their experiences and perceptions of the course.

Based on this survey ($n = 15$), it seems that most students felt the course was both effective for enhancing core knowledge and a useful learning experience for cultivating professional/public communication skills, as evidenced by the following comments:

- "Learning how to quickly compile a snapshot of the literature and distill it into a form that is accessible to the general public is a great skill to have."
- "Good practice in reviewing and combining multiple articles with different conclusions into a recommendation to give a subject or patient."
- "Being able to explain scientific findings to a lay audience is a critical skill, and one that I developed in this course. Also being able to critically review literature and come up with my own conclusion is something I'll use in whatever field I end up in."
- "I think the ability to write and speak in front of an audience is an important skill that many of us will continue to use in the future."
- "[Increased my] ability to work with different personalities. Inevitably, it was easier to communicate with and understand some people than others."
- "Gaining experience in speaking/writing to a lay audience will give you the ability to reach more people with the information you have, whether this is in a community outreach program, the boardroom, or even in general conversations."

In addition to these comments, students' ratings of the course suggested that it was as effective as a standard class format for teaching core knowledge related to physiology and aging (Fig. 2). In fact, the majority of students preferred the course format to that of a standard lecture or seminar. Moreover, students consistently indicated that the literature review experience and writing/communication skills they acquired in the course were particularly valuable and that the course itself was perhaps more valuable than other graduate physiology courses (Fig. 2). Interestingly, student opinions on the concept of compiling their work for a website were mixed, and the website did not appear to be a motivational factor for developing effective communication skills.

Discussion/Conclusions

Our primary goal in designing and teaching this course was to use group PBL with a focus on evaluating literature and summarizing it for a nonscientific audience to promote several key competencies in graduate students: *1*) the development of core biomedical knowledge, *2*) research/analytical abilities, and *3*) broad communication skills. Based on student feedback, we believe the course enhanced core knowledge as much as any standard course and that it was particularly valuable for promoting students' analytical abilities and public communication skills.

Promoting public communication skills is an important but underemphasized goal for graduate education. On one level, graduate students (like most scientists) have an intrinsic desire

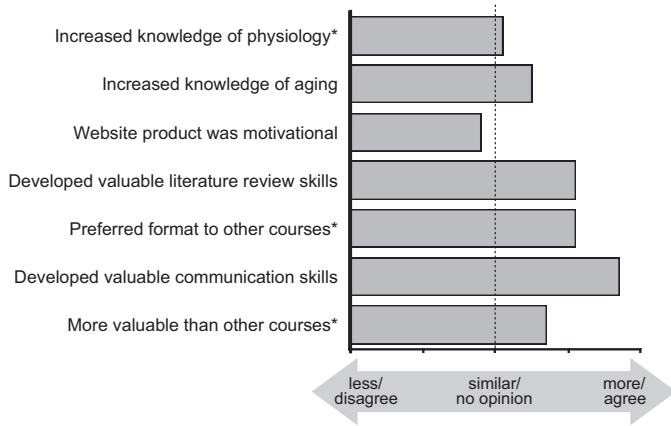

Fig. 2. Student responses to questions rating the efficacy and utility of the course ($n = 15$; mean data presented on a common Likert scale). Questions were based either on a scale from "less" to "more" or from "disagree" to "agree." *Questions in which students were asked to compare the course with other traditionally designed graduate physiology courses they had taken.

to share their knowledge to advance science and scientific literacy (7), and it is our job as educators to encourage and facilitate practice in this area. More practically, the dissemination of knowledge for the good of society will be a fundamental expectation of graduate students bound for academic research careers (3, 5, 13), and communicating science to general audiences will be a critical task for those who become health care providers, public health/policy workers, and other science professionals. Communicating this knowledge clearly is especially important in the context of key social, economic, and public health problems, from climate change to rising obesity rates to population aging (6, 8, 11).

Unfortunately, for many scientists, it is difficult to carve out time for public communication in the face of busy research, publishing, and teaching schedules. Indeed, these are high-priority items. Consequently, most graduate programs focus on preparing students for these tasks, emphasizing core knowledge and research/analytical abilities. These competencies also tend to be the major focus of research on novel strategies for graduate student education. Successful strategies like PBL and flipped classroom models require students to develop as independent learners, analyzing information and acquiring knowledge in preparation for their careers (9, 10, 14). Strategies for enhancing public communication skills do exist (7), but they are typically treated as extracurricular (i.e., not built into graduate programs). Here, we integrated communication skills/practice into a standard course by using public communication as a vehicle for PBL. Thus, we were able to provide students with communication skills/practice without sacrificing the development of core knowledge. Most scientists agree that communication skills are valuable and that being able to connect with a broad audience is uniquely important (2, 12). However, although others have reported that graduate students in various disciplines find engaging in public outreach rewarding (13, 15), to the best of our knowledge, this is the first example of a course focusing on public communication skills to enhance graduate student training in physiology.

We chose to structure our PBL project around the concept of building a website, which could eventually make the students' work available to the public. However, our data suggest that this aspect of the project was not particularly motivating for students. Arguably, this is good news. It supports the idea that graduate students are intrinsically motivated to develop their public communication skills (7) and suggests that they will derive value from a course including a focus on these skills regardless of the goal. Thus, instructors could design courses based on our template with any hypothetical outcome in mind. Examples might include press releases, magazine articles, newsletters, or even multimedia videos.

Importantly, our goal here was simply to describe an exploratory educational project, and we did not use any validated instruments for assessing student learning (our data are based on student opinions). However, our story suggests that future research on this topic would be worthwhile. Ideally, this would include quantitative pre-/postassessments of student performance and learning and perhaps even lay audience evaluations of students' writing and/or presentations (i.e., to evaluate improvements in public communication skills as a result of specific course features). This could be facilitated by new online platforms, such as "crowdgrading," and might even offer opportunities for community outreach in which graduate students engage and interact with the public.

Broadly, we believe the general concept of using public communication skills/practice as a vehicle for graduate student learning can be applied to any topic with public health relevance in physiology. We suggest a key step for any instructor considering this approach is to identify a feature of his or her course material that could be relevant and interesting to a broad audience. In our case, interventions that may promote healthy aging served as a hot topic that is clearly important from a public health perspective (11). However, based on the fact that graduate students appear to be intrinsically motivated to share their knowledge with broad audiences, any topic that is recognizably interesting for nonscientists would likely work well. The logistics of organizing such a course will depend on instructor preferences and available time/resources, but we hope that the experience we have described here may serve as a template for anyone interested in incorporating public communication skills into their curriculum.

DISCLOSURES

No conflicts of interest, financial or otherwise, are declared by the author(s).

AUTHOR CONTRIBUTIONS

T.J.L., J.N.J., D.R.S., and C.R.M. conception and design of research; T.J.L., J.N.J., D.R.S., and C.R.M. performed experiments; T.J.L., J.N.J., and C.R.M. interpreted results of experiments; T.J.L. prepared figures; T.J.L. drafted manuscript; T.J.L., J.N.J., D.R.S., and C.R.M. edited and revised manuscript; T.J.L., J.N.J., D.R.S., and C.R.M. approved final version of manuscript.

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