Encouraging science reading beyond the curriculum

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ABSTRACT: Students in genetics and reproductive physiology, junior-/senior-level courses with enrollments averaging 76 and 41 students, respectively, were encouraged to read popular science books for extra credit. The objectives of the readings were to reinforce basic class concepts by forming ties to everyday life, and to expose students to a genre that can provide information to prepare them as citizens to engage in the debate over current issues. The books for genetics were The Double Helix, Genome, Voyage of the Beagle, and The Engineer in the Garden; and the books for reproductive physiology were Clone, Lives of a Cell, Life Before Birth and A Time to be Born, and The Second Creation: Dolly and The Age of Biological Control. To earn credit (3% of the course grade for each of up to three books), students had to demonstrate knowledge and understanding of each book during a 15-min discussion with the instructor. Discussions focused on questions designed to stimulate critical thinking about each book’s content. For example: “There is approximately 98% homology in DNA sequence between humans and chimpanzees; in aspects ranging from basic physiology to behavior, what makes us similar to or different from the species that is our closest living relative?” The numbers of students reading three books in Years 1 and 2 were 2 and 12 in genetics, and 4 and 3 in reproductive physiology; those reading two books in Years 1 and 2 were 5 and 20 in genetics, and 0 and 2 in reproductive physiology; and those reading one book in Years 1 and 2 were 21 and 31 in genetics, and 7 and 8 in reproductive physiology. The numbers of students that read no books in Years 1 and 2 were 33 and 27 in genetics, and 45 and 20 in reproductive physiology. Participation in the reading project occurred independently of course grades. Sixteen genetics students from the second year’s class, eight that had participated in the extra credit reading and eight that had not, volunteered to be reexamined on material from the class. The reexamination was conducted 3 mo after the end of the class. With first exam score fitted as a covariate (\(P<0.10\)), participation in the extra credit reading assignment did not affect score on the reexamination; participants averaged 67% correct answers, nonparticipants averaged 59% (\(P=0.37\)). Comments on course evaluations indicated broad satisfaction with the assignments. Although no improvement of retention could be documented from this project, our objective of encouraging students to engage in reading material supplemental to courses in genetics and reproductive physiology was satisfied.

Key Words: Extra Credit, Pedagogy, Reading

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Introduction

Thomas and Rohwer (1993) reported that reading is among the most important means for citizens to acquire critical, in-depth information. Despite the critical need for reading skills, exit interviews of graduating seniors from the University of Missouri’s College of Agriculture, Food, and Natural Resources revealed that among the skills surveyed (including writing, oral presentation, critical thinking, and problem solving), reading was the skill least adequately addressed in their college education (P. Vaughn, University of Missouri, personal communication).

Chickering and Gamson (1991) outlined seven principles of good practice for undergraduate education, briefly summarized as follows: 1) contact between faculty and students in and out of class should be encouraged; 2) reciprocity and cooperation among students should be developed; 3) learning should be active; 4) feedback should be prompt; 5) time on task should be emphasized; 6) expectations should be high; and 7) diverse talents and ways of learning should be respected. Encouraging reading outside the curriculum, when combined with appropriate discussion and evaluation, can incorporate all seven of these principles. Key components of the project are the choice of books, emphasizing those that relate material in class to the everyday lives of the students, and the critical interactive think-
ing exercise (CITE) questions (Peters et al., 2002) used to facilitate depth of thought during the student-faculty discussions.

Reading outside the curriculum is a pedagogical device that can enhance learning in any type of course. Therefore, it was our objective to develop and implement programs of supplemental reading in courses in genetics and reproductive physiology.

Materials and Methods

Procedure

Books were chosen that complemented the material presented in two classes in the animal sciences curriculum. The classes were reproductive physiology and genetics of agricultural plants and animals. In each class, principles of the topic area were covered with applications directed primarily to domesticated livestock and, in the case of the genetics class, agronomic crops. The supplemental reading was designed to broaden the perspectives of the participating students by introducing them to topics based on the principles from class, but with greater application to everyday human life, and covered in detail beyond that possible in class. Books for the genetics class were The Double Helix, Genome, Voyage of the Beagle, and The Engineer in the Garden; books for reproductive physiology were Clone, Lives of a Cell, Life Before Birth and A Time to be Born, and The Second Creation: Dolly and the Age of Biological Control.

Student participation in the reading project was optional. The books were made available to students and extra credit points were used as inducement for them to participate. The possible extra credit points for each book read were equal to 3% of the points in the course, and students could read up to three books; thus, full participation by a student could potentially result in an increase in the course grade of nearly a full letter grade. To earn the extra credit points, the students participated individually in a 15-min discussion with the instructor of the material in the book. Extra credit points were only available to those that read the material and gained sufficient depth of understanding such that they could participate meaningfully in a discussion on the topic. To discourage students from attempting to gain points by participating in the discussion without having fully read the book, partial credit was not given.

The discussions used a series of CITE questions (Peters et al., 2002). The CITE questions were designed to stimulate critical thinking about issues covered in the reading and stimulate discussion that extended beyond the topic of a particular book. A sample set of CITE questions for Genome is as follows:

Chromosomes X and Y: What evidence exists that there is a gene that influences sexual orientation, and if one does exist, what are its implications for laws regarding the rights of gays and lesbians?

Chromosome 2: There is approximately 98% homology in DNA sequence between humans and chimpanzees; in aspects ranging from basic physiology to behavior, what makes us similar to or, conversely, different from the species that is our closest living relative?

Chromosome 4: Huntington’s disease is an incurable and fatal genetic disease that follows a dominant pattern of inheritance. A test is available that is reliably predictive of whether the disease will strike and when. Assume your paternal grandfather died from Huntington’s disease; should you be tested, and should the results of the test be public information?

Chromosome 6: Intelligence is a characteristic that has not been definitely linked to specific genes. If a young, single person had a particular goal of having exceptionally intelligent offspring, what steps could he/she take to achieve that goal?

Chromosome 13: The enzyme lactase allows adults to digest lactose and thereby drink milk. Lactase production is normally shut off after childhood, but there is a mutation that allows adults to produce lactase and consume lactose. The frequency of the mutation varies among populations, with highest frequencies found among those with ancestors having lived a pastoral lifestyle. How have these individuals caused their genomes to be modified to conform favorably to their lifestyles? Or, what is the explanation for these groups that need the adult lactase mutation for having it?

Chromosome 19: APOE is a polymorphic locus on chromosome 19 that affects the incidence of heart disease. The highest frequencies of the detrimental allele are found among Scandinavians, Polynesians, Africans, and New Guineans. What has caused the differences in allele frequencies, what is the mechanism of the gene, and what are the implications for human health?

Evaluation

To help understand the motivation for reading books for extra credit, the relationships of several factors with participation in the project and number of books read were examined. The relationship between number of books read and course letter grade was tested by using a $\chi^2$ test. The number of books read was fitted to a model including the effects of course (genetics or reproduction), year (1 or 2), and their interaction in an ANOVA.

To test the hypothesis that students used the extra credit assignments to gain enough points to move their grades to the next higher letter grade, a variable denoted grade deviation was created by subtracting the lowest percent grade within each letter grade from the percent grade of each student within that letter grade category. For example, the lowest B in genetics in Year 2 was 80%. The percent grade of each student receiving a B in genetics in Year 2 had 80 subtracted from it. Thus, the grade deviation ranged from 0, for the student receiving the lowest B (an 80), to 8.8 for the student receiving the highest B. Grade deviation was then fitted to a model including the effects of course, year, partici-
pation in the extra credit assignment, and their interactions.

Students from the second year’s genetics class were asked to participate in a reexamination over material from the class (University of Missouri IRB Approval 1042747). Sixteen students participated; eight that had participated in the extra credit reading and eight that had not. An examination of material covered in the course, but not directly related to the possible readings, was administered to these students. Scores for the reexamination were analyzed by using a model including the effect of reading participation and a covariate of first exam score. The reading project did not begin until after the first exam had been presented in the class; thus, extra credit reading would not have been expected to affect the students’ scores on the first exam. First exam score could be used to help correct for differences in performance between participating and nonparticipating students.

Results and Discussion

Among the 233 students in these courses, 108 students read books during the 2 yr of this project (Table 1). Students in the genetics class read more books for extra credit than students in the reproduction class (0.90 vs. 0.44 books per student; \( P < 0.001 \)), and students in Year 2 read more books than students in Year 1 (0.86 vs. 0.47 books per student; \( P < 0.01 \)). The interaction between course and year was not significant. These data suggest that participation increased as students became more familiar with the assignment. It is less clear why there was greater participation in genetics than reproduction. It may be that students perceive genetics as being a more difficult course, although the distribution of grades did not differ significantly between the two courses, or that different instructors for the two courses may have promoted the assignments differently.

The numbers of students that read one, two, and three books were 60, 27, and 21, respectively. Participation in the reading project occurred independently of course grade (\( P = 0.14 \)). The percentages of students participating by course grades were 50, 49, 50, 38, and 10 for A, B, C, D, and F, respectively. The percentages of students receiving each grade were 26, 33, 25, 12, and 4 for A, B, C, D, and F, respectively. It seems that students who failed a course may have been less likely to read books for extra credit; however, the number of students that failed was small (\( n = 10 \)).

It was somewhat surprising that participation was independent of course grade. There was clear anecdotal evidence to suggest that some students read books to receive extra credit points to improve their grades. Participation, however, was numerically higher for students receiving grades of A, B, or C, than for students receiving grades of D or F. Anecdotal evidence also suggested that some students read books independent of any desire to improve their grade. Those students were aware that they were already at the top of the respective classes and would not directly benefit from additional points, yet they chose to participate in the project anyway.

The analysis of grade deviation suggested that students, particularly in Year 2, may have used the extra credit assignments to gain enough points to move to the next higher letter grade. In that analysis, grade deviation was affected by participation in the extra credit reading (\( P = 0.06 \)), year (\( P = 0.04 \)), and the interaction of year \times\ participaction (\( P = 0.10 \)). The mean grade deviations for participating students in Years 1 and 2 were 4.0 and 2.2, respectively, and for nonparticipating students in Years 1 and 2 were 4.1 and 3.9, respectively. The overall mean grade deviation was 3.6. The value of 2.2 for participating students in Year 2 suggest that many participating students effectively used the extra credit points to move their percent grade slightly above that needed to move into the next higher letter grade range.

To further investigate this idea, we examined the proportion of students whose letter grade would have been decreased had they read one fewer book for extra credit. The extra credit points awarded for completing a book were equal to approximately 3% of the course grade. If motivation was unrelated to the consideration of moving the percentage just enough to increase the grade by one letter, decreasing the number of books read by one book would be expected to decrease the letter grade of 30% of participating students. In Year 2, if participating students had each read one fewer book, 68% (\( P < 0.01 \)) would have had their course grade decreased by one letter.

Did participation in the project improve student performance or retention? Unfortunately, the project was not designed to measure this with sufficient power to provide conclusive results. Sixteen students from the second year of genetics, equally divided between participants and nonparticipants, volunteered to be reexamined over course material not directly related to the material covered in the extra credit readings. Participants averaged 67% correct answers, whereas nonparticipants averaged 59% (\( P = 0.37 \)). Power for this analysis, calculated from the experiment’s values for difference and variance, was equal to only 0.14. Seventy-five students in each group would have been needed for reexamination to achieve a power of 0.80. Many studies

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have shown that there is better retention of information when it has personal meaning to the learner (Angelo, 1993).

In exit interviews of graduating seniors from the University of Missouri’s College of Agriculture, Food and Natural Resources, reading was found to be the skill least adequately addressed in their college education among skills surveyed including reading, writing, oral presentation, critical thinking, and problem solving (P. Vaughn, personal communication). Nonetheless, reading remains among the most important means for citizens to acquire critical, in-depth information (Thomas and Rohwer, 1993). The recent trend toward basic research has narrowed the focus of disciplinary courses to new scientific knowledge. Our courses are not exceptions, but societal problems span a broader need (Vietor et al., 1996). A long-term goal of this project has been to expose students to, and encourage development of the habit of reading, books that can provide information relevant to issues of concern to the engaged citizenry. Irrespective of any effect on performance and retention, this project encouraged students to read material supplemental to two animal sciences courses.

Literature Cited


