

Genetics Education Note

Innovations in Teaching and Learning Genetics

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Teaching How to Prepare a Manuscript by Means of Rewriting Published Scientific Papers

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ABSTRACT

The objective of the course described here is to train undergraduate students to write a scientific manuscript. The students participate in selection of a current topic in contemporary genetics or molecular biology by choosing the most interesting paper of a given year. After the teacher provides all essential background about the selected subject, he or she selects a recent article from the corresponding field and presents the students with all the necessary information contained in the paper without revealing its title and author. The data presented in the paper are reviewed by the class so that each student understands every experiment and the main points of the work. Simultaneously, the students are informed about the basic rules of writing the individual sections of a scientific paper. They are then asked to write and formally submit a manuscript summarizing the data. Finally, the students act as reviewers of their colleagues' manuscripts and compare their papers with the original published articles. This enables them to identify both the strengths and the weaknesses of their manuscripts and to gain confidence in the writing skills that will be so critical for their future scientific activities.

W RITING papers summarizing and interpreting experimental data is one of the most important skills needed to become a successful scientist. Yet undergraduate students often lack even a basic understanding about the process of publishing scientific articles. Students often do not realize that even the most exciting data may not be acceptable for publication in the scientific community if presented in a poorly written style in a manuscript.

There are certainly many schemes for training undergraduates on how to write a scientific paper. However, these schemes often lack “a control sample,” *i.e.*, an example of how the same results would be described by an established and successful scientist. This is the basic concept for the seminar course described below, which represents an alternative means for teaching undergraduate students how to write a manuscript for a scientific journal. An outline of the course is presented in Figure 1.

During the first session, the teacher describes the process of publishing a scientific paper (Figure 1, Introduction to scientific publishing). Several questions are addressed: What criteria should be considered when choosing a journal? What is the impact factor? What is an editorial board and what is its role? What is a peer review? What should be done when a paper is rejected? Why is it important to read the proofs? Why do authors pay for publishing their contributions? Selection of an appropriate journal is only a small step toward final publication. It is emphasized that it may take a long time from writing the first draft of a paper to its publication in a journal. The possible outcomes from “rejection without review” to “accept in its original form” and the strategies to deal with these situations are described.

The second stage of the course involves a topic selection (Figure 1, Choosing a topic). To involve students in this task, the teacher asks them to browse the scientific literature in the fields of genetics and molecular biology over the past 1–2 years and to choose an experimental paper, which, in their opinion, presents the most interesting discovery. They briefly (5–10 min)

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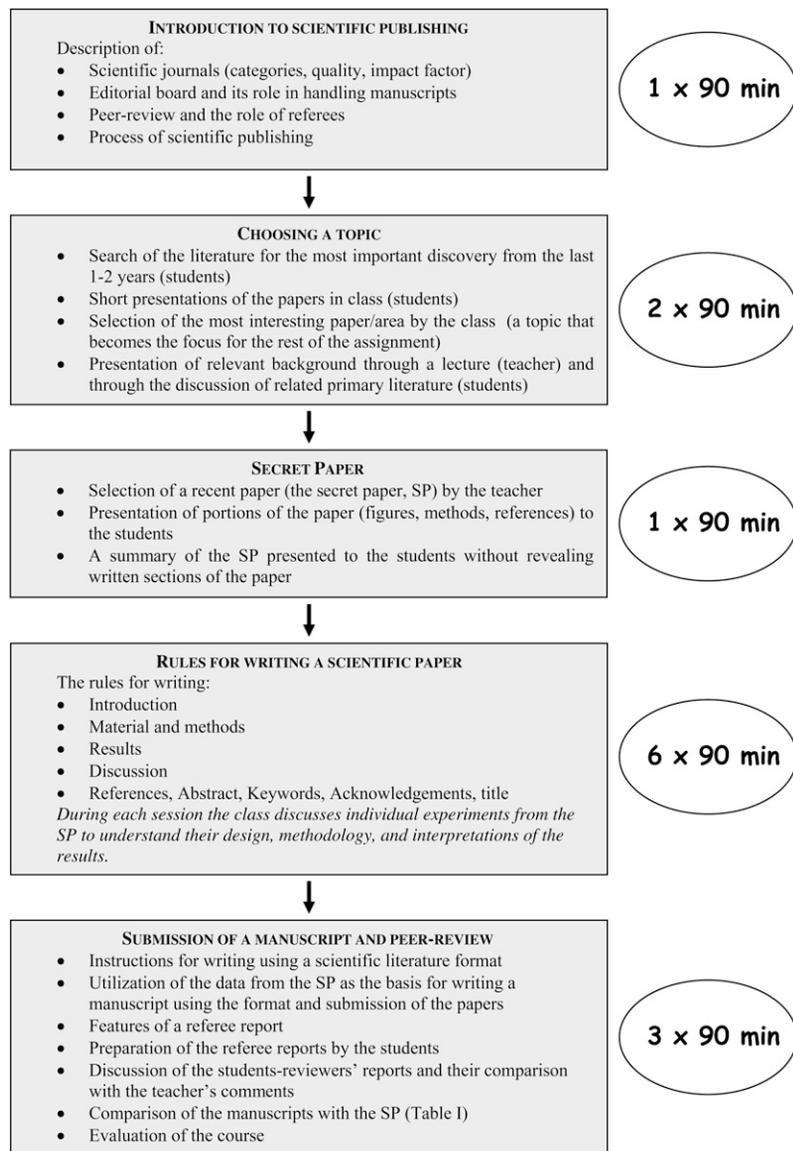


FIGURE 1.—Stages of the course on writing scientific papers. Each stage is represented by a rectangle containing examples of the addressed points. The average size of the class is 12 students. Thirteen 90-min classes are held during the semester. The course is designed for juniors (fourth year of the 5-year college curriculum) and is worth 2 credits (60 is the minimal number of credits per school year at Comenius University).

present the main points of the paper and explain why they believe it is the best article of a given year. After all presentations and a brief follow-up discussion, the group decides which presentation was the most convincing. The decision is usually reached by a consensus; if an ambiguous situation arises, the teacher will make the final decision.

After selection of the topic, the teacher's role is to provide background about the area of research. This can be performed on two levels. First, the teacher prepares a brief (30-min) presentation on the topic based on both textbook information and recent review articles. Second, the teacher selects a series of recent experimental articles on the topic and asks the students to prepare journal club presentations that summarize the data. The combination of passive (lecture) and active (journal club) teaching enables students to gain substantial information about the topic and to prepare for the next stage of the course.

Next, the teacher selects an article that will be the subject for the remainder of the course [Figure 1, secret paper (SP)]. It is important to choose a SP that (i) is on the topic selected by students, (ii) represents an important contribution to the field, (iii) is based on sound experimental results, and (iv) employs experimental methods that are understandable to undergraduate students. [One can argue that it should not take much effort for a student to identify the SP by a simple database search. However, when students are asked to consider the course as a game with the rule of not trying to identify the SP, most of them (>90%) resist this temptation.] The students are given selected sections (namely, figures and figure legends, Materials and Methods, and selected references) of the SP on a CD. The teacher summarizes the paper and discusses the results in the form of a journal club. Finally, the instructor, together with students, goes through all experiments, making sure that every student understands the

experimental design, methodology, meaning, and interpretations of the results.

Along with a detailed presentation of the experimental results of a SP, the teacher provides guidelines for the assignment and describes the main rules for writing individual sections of the manuscript (Figure 1, Rules for writing a scientific paper). Namely, the teacher explains how to write the Introduction; how to describe the Materials and Methods; how to present the Results; the rules for Discussion; how to collect references and cite them throughout the text; how to sell a story in the abstract; the importance of choosing a catchy and informative title; the role of keywords; and how and whom to acknowledge. To exercise these rules, the students are asked to write a paragraph of a section (*e.g.*, Introduction, Results, or Discussion). The paragraphs are then evaluated by the whole group and the teacher pinpoints their strengths and weaknesses. Choosing a title can be made entertaining by voting on the most appealing version from a pool of titles suggested by students. If desired, all information and comments accumulated throughout the course may be typed “live” using a PowerPoint presentation. The final file can be provided to students either as a CD or from a departmental server.

After students understand all the experiments in the SP and have an idea of the purpose for each section of a scientific manuscript, they are ready to write a scientific paper on the subject (Figure 1, Submission of a manuscript and peer review). To have all papers in the same format, the teacher gives students the Instructions to Authors, which are provided by the journal of choice. Students submit two hard copies of their manuscript: one signed and one with an alias that will be provided to an anonymous reviewer, *i.e.*, to another participant of the course. Before “sending the papers for review” the teacher describes the details of the review process, especially the structure of the reviewer’s report. As an example, the teacher can show real referee comments from one of his or her own papers. Referees then read and evaluate the strengths and weaknesses of a manuscript and indicate what changes should be made to make it acceptable for publication in the journal. A great advantage is that each referee is also an author of a manuscript on the same subject, so he or she can compare his or her writing technique with that of a classmate. It is interesting to witness how harsh students can be when evaluating the work of their colleagues; sometimes they are even harsher than actual reviewers in the scientific field. Even in these cases, the seminar is still presented as a game in which all participants should have fun while they are learning.

To evaluate the papers, each student receives the review written by the colleague–referee. The reviews are discussed during a class meeting and the teacher emphasizes their strong and weak points. In addition, the teacher, who acts as a second referee, prepares his or

TABLE 1
Comparison of the student’s manuscript with the original paper

Parameter	Points	Description
General weaknesses		
General strengths		
Formal style and readability		
Appropriateness of the title		
Information content of the abstract		
Suitability of the keywords		
Sufficiency of the background in Introduction		
Description of the experimental data		
Critical interpretation of the data in the Discussion		
Sufficiency of citations of relevant literature		
Other	XXX	

Each parameter of the manuscript is compared with the original paper. The point scale is 1 (poor) to 10 (excellent). The questionnaire is filled out independently by both the student (self-assessment) and the teacher. Both evaluations are then combined and compared.

her own review of each manuscript and pinpoints its strengths and weaknesses. The emphasis should be given to the content and style of individual sections of the paper. The teacher compares the manuscripts with the SP and lists sections that, according to his or her opinion, are worse, better, or similar to the SP. The teacher’s reviews are also put side by side with the students’ referee reports of the corresponding manuscripts, and the comments are compared. Finally, the students are asked to submit a revised version of their manuscripts together with a cover letter summarizing responses to the reviewers’ comments.

Of course, students can acquire writing skills in more conventional literature-based classes where they might write papers in which they review the current literature and propose additional experiments. The course described here is not a substitute, but rather a complement of such classes. Comparison of the student’s manuscript with the original paper provides a unique chance to self-assess his or her style of writing with that of a paper on the same subject that has passed through a rigorous peer-review process. Namely, the students are asked to fill out a questionnaire (Table 1) and to evaluate various parameters of their manuscripts with the SP. The same questionnaire is also filled out by the teacher and both evaluations are then combined and compared. Importantly, if they find out that some sections of their papers have quality comparable to the SP, the students gain confidence in their writing skills. Although this conclusion is not based on formal course evaluation (which is not utilized by Comenius University), the students unanimously expressed excitement about the course’s benefits during the discussion at the final class meeting.

They appreciated that (i) the topic selection is student driven; (ii) they obtain relatively detailed information about the cutting-edge research in a field that is usually not the subject of general courses; (iii) they can train themselves to write a real scientific paper and compare their manuscripts with a paper that has passed peer review; and (iv) they gain some insight into the process of submitting, editing, and reviewing scientific papers. With respect to their reservations, the students complained about a relatively low payoff (two credits, which is <5% of the minimal number of credits that they must earn during the school year), undoubtedly because of the demanding investment of time needed to complete the course. Yet, they all agreed that the benefits outweigh this drawback.

The course is challenging also for the teacher. There are two particularly sensitive issues. First, it is important to be actively involved in the selection of the topic and to select a subject that is neither too general (*e.g.*, cancer) nor too specialized (*e.g.*, mutation analysis of a domain of a particular protein) and one that represents a current area of research. Second, it is essential that, after reading the manuscripts, the teacher makes specific comments for each student so that the positives and negatives of the text are clear. This is especially

demanding considering the fact that the teacher has to read several papers on the same subject. However, these investments are compensated by several benefits. Since the topic of the course is chosen every year, there is no chance for a repetition and thus the course does not become routine. In addition, the teacher is forced to follow literature from a wide range of fields, which can be highly advantageous for his/her own research. The scheme of the course is not limited to genetics and molecular biology and it can be easily adopted by disciplines outside the life sciences. Finally, by rewriting existing scientific papers, students perform a controlled experiment in the form of a game that provides excitement analogous to the pleasure provided by experiments performed at their laboratory benches.

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