FORUM

Teaching Entomology: Moving from Paternalism to Active Learning

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Ensino de Entomologia: Mudando do Paternalismo para a Aprendizagem Ativa

RESUMO - Propomos uma mudança na maneira tradicional de ensinar Entomologia na graduação e na pós-graduação. Para tanto, sugerimos um sistema no qual estudantes de graduação e pós-graduação interagem, discutindo Entomologia fora da sala de aula. Isto que os levaria a procurar conhecimento ativamente, ao invés de serem paternalisticamente "ensinados" sobre como devem aprender. Tal sistema não elimina aulas nem professores. Ao contrário, acreditamos que aulas e discussão extra-classe são complementares para um ensino efetivo. Nossos resultados mostram que estudantes de graduação e pós-graduação que interagem extra-classe obtêm melhores notas do que aqueles que não interagem, mesmo quando submetidos a provas elaboradas no estilo tradicional. Mais interessante ainda, evidências levam a crer que pós-graduandos envolvidos neste sistema conseguem empregos permanentes mais rápido do que os demais pós-graduandos. Aparentemente, a discussão extra-classe permite que o estudante pense livremente, ao invés de simplesmente acumular a informação passada durante as aulas. Fazendo isto, o estudante transforma informação em conhecimento e, por isso, é capaz de resolver até mesmo problemas com os quais nunca se deparou.

PALAVRAS-CHAVE: Didática de entomologia, pensamento, raciocínio, aquisição de conhecimento.

ABSTRACT - We propose a shift in the traditional way to teach Entomology for undergraduate and postgraduate courses. We envisage a system in which undergraduate and postgraduate students interact, discussing Entomology outside the classroom. This would get them to actively seek for knowledge, rather than being paternalistically told how they should learn. Such a system does not preclude lectures as a didactic strategy, nor it rules out lecturers as responsible for instructorship. On the contrary, we believe lectures and discussion outside classroom are complementary for effective teaching. Our results show that undergraduate and postgraduate students who interact outside classroom are able to get better grades even when submitted to traditional written tests. Moreover, it seems that postgraduate students who get involved in such a system get permanent jobs faster than those postgraduates not taking part in it. Apparently, the

key here was that when discussing outside classroom, students are allowed to think freely, rather than simply accumulating information taught in classroom. In doing so, they transform information into knowledge, and therefore, are able to solve even unforeseen problems.

KEY WORDS: Didactics of entomology, thinking, reasoning, knowledge acquisition.

If Entomology is as fascinating as entomologists say, why is it that many students sleep in our classrooms? A comfortable answer would be: "...students nowadays do not want to learn; I miss those old good times when lecturers were respected and students were responsible. If anyone can be blamed, it is certainly not the lecturers or the academia itself". Fortunately enough, the majority of the lecturers do not share the above opinion. We have interviewed a selected group of lecturers of Entomology, from a wide range of Brazilian universities, and the vast majority agreed that the problem is structural, related to the way we teach Entomology to both graduate and postgraduate students (Fig. 1).

Lecturers agree that the student should be motivated. That is, even when the student is

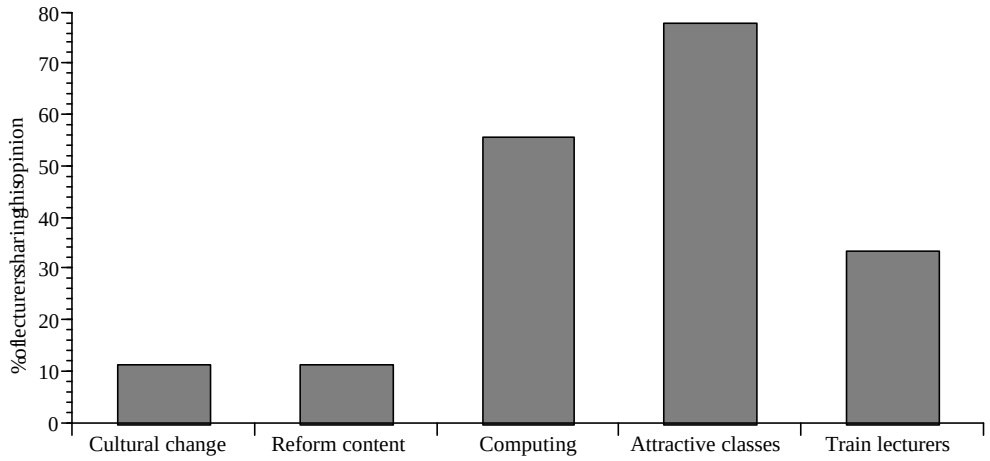

Figure1. How to improve the way we teach Entomology? "Cultural change": there is no way to solve the problem within academia; the problem is cultural. "Computing": use computers in the classroom. "Reform content": revise the subjects taught in classroom. "Attractive classes": adopt strategies to make classes more interesting for the students. "Train teachers": provide lecturers with training on didactics. Such opinions were collected from ten lecturers, who were allowed to express themselves freely: the interviewer simply took note of the answers. After this, all similar answers were grouped into their respective category. The opinions are presented as categories in the *x*-axis while the *y*-axis presents the percent of lectures sharing that opinion. Lecturers chosen hold a PhD degree, are nationally renowned as entomologists, and belong to a wide range of Brazilian universities.

not primarily interested on Entomology, we must find a way to draw his/her attention to our subject. Easy to say, difficult to do! Basically, one can affect motivation for learning in two opposing ways: by increasing the *value* of learning or by affecting the students' *expectancy* that enrolling in course activities will lead to success in achieving their goals (McKeachie 1999). Increasing the value of learning has been extensively used, and easily misused. This is the strategy of focusing course goals on the grade to be obtained, rather than on the learning activity itself. It is an inversion of objectives, simply because grading may be a tool to measure learning, but it is not an aim itself. When we focus our objectives on grading, it is very easy to be worried about the amount of subject taught, hours spent in classroom, and credits assigned to a course. Other activities, such as discussion and interchange of ideas between teacher and student, as well as among students themselves, would tend to loose importance. How many times have you heard - or even spoken - during a class, the anecdotal phrase: "...if you do not stop asking, I'll never fulfil the whole syllabus"? Such a phrase reveals the assumption that students are nothing but mere repositories of knowledge and, worse still, teachers are the unique source of such a knowledge. Under this assumption, students must be carefully guided throughout pre-defined, teacher approved, paths that lead to knowledge. Such a paternalistic approach provides ineffective learning due to, at least, two problems: (i) not all students learn in the same way (Felder 1993), thereby what is a suitable path to someone may be not for another; and (ii) there is no such a thing as a super-human teacher (Felder 1994), thereby a student can look for sources of knowledge other than the lecturer.

On the opposite end of paternalism, we find those lecturers who completely abandon the student to his/ her own fate. This is the classical approach of those who are not committed to teaching. Pretending they are improving the student exposition to new ideas, such lecturers will always invite speakers to teach on their behalf. After a whole semester, the class will have had a series of lectures given by postgraduate students, lecturers from other universities, and so on. The lecturer in charge of the course, however, will remain as a complete stranger to his/her students.

We propose an intermediate approach: lecturers should guide students through their learning process, in such a way that students are not prevented to think, hence being able to actively look for knowledge. If this is a better approach than the paternalistic one, students involved should profit from it by being able to get good marks even when tested by traditional grading systems. Moreover, if this is a better approach it should be general enough to produce good results for undergraduates as well as postgraduates. It is beyond the scope of this article to discuss the suitability of grading as a tool for measuring learning. We simply use it here because it is a standard procedure, and as such, allows our results to be comparable across a wide range of situations.

This paper, therefore, tests the hypothesis that postgraduate and undergraduate students achieve better performance in Entomology, by interacting with each other than by simply attending classes.

What is our proposal?

We propose to attract the students' attention to Entomology, by focusing their attention on the learning process rather than on the amount of information they are able to accumulate. To do so, we stimulate active learning by encouraging undergraduate students to exchange ideas with postgraduate students, solving doubts related to lectures as well as homework. The original inspiration for such an integration between undergraduates and postgraduates was concieved by the Brazilian Governmental Agency responsible for improving higher education (CAPES). Such a program is generically known by the acronym PROIN, which refers to the integration mentioned above. CAPES has sponsored many of such initiatives all over Brazil. Such

a Program has been discontinued from 1999, which is unfortunate in view of the improvements it provides to both, undergraduate and postgraduate students. This article shall report one example of these improvements.

The idea here was to get both, undergraduates and postgraduates, actively involved in solving these doubts, free from the direct influence of the teacher. When acting as tutors, postgraduates were instructed to not provide the undergraduates with the right answer immediately. Rather, they would help the undergraduates to *think* in terms of the subject matter, through what could be called a "socratic" procedure. To understand how this would work, see the dialogue below, between an undergraduate and his/her postgraduate tutor:

Undergraduate (U): "- Which Order does this insect belong to?"

Postgraduate tutor (PT): "- Which Order do you know to have this insect's characteristics?"

U: "- Huh, I think it is Lepidoptera"

PT: "- Why?"

U: "- Because Lepidoptera have scales on their wings, and this insect does...huh...does not! oh, gosh! it is not Lepidoptera!..."

From this point on, the postgraduate would drive the discussion till the undergraduate finds, mostly by him/herself, the right answer.

Such a system runs currently within the course "General Entomology", which is the very basic subject in Entomology taught to second-year undergraduates following Agronomy, Animal Husbandry, Biology, and Forestry, in the Federal University of Viçosa, Brazil. Postgraduate students (M.Sc. and D.S.) are enrolled in the Graduate Program in Entomology of the above University. The course was carried out as usual, with the classical lecturing arrangement of two theoretical hours plus two practical hours per week, during 15 weeks. In addition to that, tutorial hours were provided every day, according to the tutor availability. No extra workload was inflicted to the students. Undergraduate students could go to as many tutorials as wanted; or could even opt not to get involved, as many did (thereby providing us with the statistical control for testing our hypothesis). Postgraduates also got involved voluntarily, spending a maximum of four hours per week in such a job.

The tasks involved were:

1. answering a list of questions that cover all topics of the course. Questions were based on the content of the textbook (Gullan & Cranston 1994), and other entomological literature that could be found in our library (mainly Silveira Neto 1976, Maranhão 1976 & 1978, Free 1980, Eduards & Wratten 1981, Panizzi & Parra 1991). All questions were made available to all students, regardless whether they had opted to attend tutoring or not. No grade was assigned to those questions, but the students were aware that solving them would get one used to the kind of questions normally appearing in the exams. Questions were elaborated in such a way that no answer would involve simply *listing* things (insect characteristics, taxonomic terms, etc). Rather, the questions would explore higher levels of reasoning (Stice 1976), such as analysis, synthesis, or evaluation. A typical question here would be: "-why is the world green, if there are so many herbivore insects who are potentially able to defoliate the plants"?

2. planning and carrying out a short research program, which was reported in the form of a scientific paper, five pages long. Research must test a clear scientific hypothesis, related to Entomology, preferably with connections to the future profession of the undergraduate. Hypotheses are formulated by the undergraduate, under the guidance of the tutor and the lecturer. Data must be collected by the undergraduate student. The paper was valued 15% of the total course score.

3. alternatively to (2) above, students could collect 30 insects and arranging an entomological collection with them, identified to Order level. Insect labelling and mounting should follow standard procedures, according to Borror & DeLong (1988).

In order to evaluate the impact of such a system on the academic life of the involved students, we followed student performance during one academic semester (15 weeks be-

tween August and November 1997). During this period we measured the effect of tuition on the final mark obtained by the undergraduate student in the course "General Entomology", and on the academic performance of the tutor. Both, undergraduates and postgraduates were tested individually by means of traditional tests. Undergraduates were submitted to the tests normally applied within the course. Tests were planned independently of any of the tasks mentioned above (items 1-3), thus assuring an independent checking of the entomological accuracy arisen from the discussions among students. Postgraduates performance was assessed by noting their overall academic performance in the courses they should take in order to get their degree. Because postgraduates do not take "General Entomology", this measurement is independent of tutoring.

The effect of tuition on the final mark obtained by undergraduates was measured by plotting the number of times an undergraduate sought guidance (x-var) against the final score obtained (y-var). The effect of tuition on tutors' performance was achieved by comparing the overall academic performance of the tutor before and after his/her involvement in the system. Academic performance of the tutor was defined in accordance to the standards followed by the Federal University of Viçosa, Brazil, and was measured by calculating his/her weighted average mark across all courses followed as a postgraduate, according to the equation:

$$ap = \frac{\sum_{i}^{j} m_i \times c_i}{\sum_{i}^{j} c_i}$$

where ap = academic performance; m_i = final mark obtained in a course (i); c_i = academic credits assigned to the course (i).

Statistical significance was assessed by one-way ANOVA, testing the effect of tutoring on the performance of the undergraduate student (Fig. 2) and the effect of tutoring on the performance of the postgraduate student (Fig. 3). The opinions of lecturers regarding how to improve teaching in Entomology (Fig. 1) were not subjected to statistical tests because no hypothesis was associated to this survey. Likewise, the success of the tutors in getting permanent jobs after finishing their postgraduate courses (Fig. 4) was not submitted to statistics because the amount of data is not enough for a robust test. Despite this, we present Fig. 4, because we believed that it shows an intriguing trend.

Does it work?

During the semester under evaluation, 130 undergraduate students were enrolled in the course, nine postgraduate students (one DS and eight MSc) acted as tutors, and two lecturers shared the classes. Undergraduate students who attended tuition at least once obtained better grades than the ones not attending tuition ($F_{[1;128]} = 8.25$; $P = 0.005$; Fig. 2). Accordingly, postgraduates have increased significantly their academic performance after working as tutors ($F_{[1;8]} = 8.22$; $P = 0.021$; Fig. 3).

In addition, an unconfirmed trend (Fig. 4) allows suspicion that postgraduates acting as tutors get permanent jobs faster than postgraduates not performing such a task.

Drawbacks

Would this approach be suitable to the reality of Brazilian Entomology? We live in an academic system virtually void of money and when it comes to education (as opposed to academic administration and scientific research) the situation is even worse. As in other countries (Felder 1994), scientific research is valued above lecturing, but no lecturer get promotions only by researching. Therefore, while there is no money to support news ideas in teaching, the lecturer him/herself is too busy trying to squeeze his time into lecturing, researching, and occasionally living! In other words, there is no apparent reason, other than enthusiasm, to get involved in another intrincate task. That is in fact the point: we do not propose anything intrincate. Conducting the system, as the lecturers in charge, does not add to your time schedule significantly more than you would get in the traditional way: once the system is installed, it is amazing to see how it runs by itself. In order to get

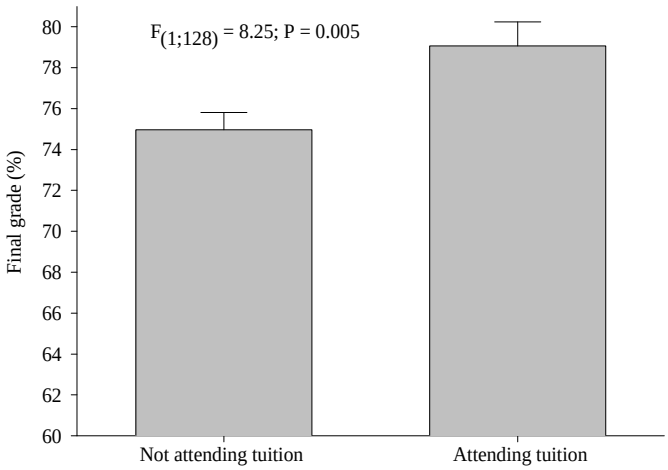

Figure 2. Performance of undergraduate students in written tests applied within the discipline "General Entomology" (BAN 160), in the Federal University of Viçosa, Brazil, in the second academic semester of 1997 (August to November). Categories are: (i) students who opted to discuss the subject with postgraduate tutors ("attending tuition") and (ii) students who opted not to have such discussions ("not attending tuition").

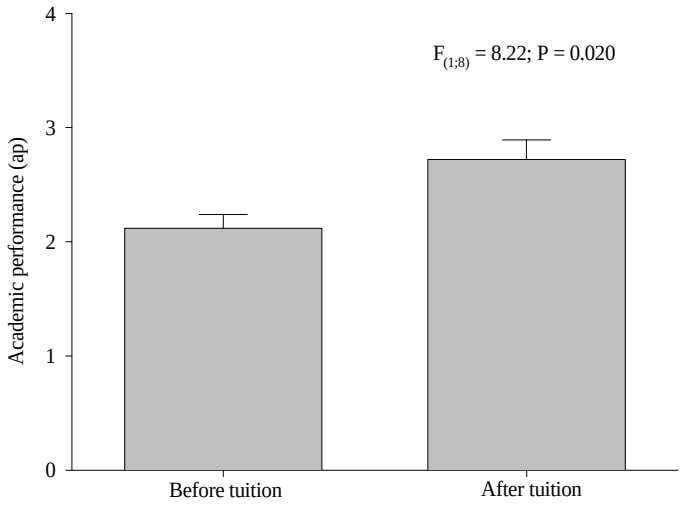

Figure 3. Performance of postgraduates students acting as tutors in the discipline "General Entomology" (BAN 160), in the Federal University of Viçosa, Brazil, in the second academic semester of 1997 (August to November). Performance is measured as the average grade across all courses taken, weighted by the respective amount of credits (see text for details). Categories are (i) the semester immediately preceding activity as a tutor ("before tuition") and (ii) the semester when the postgraduate student first acted as tutor ("after tuition"). Among the nine tutors involved in the system, four were disregarded in this analysis because they were freshers and, as such, there was no way to measure their "academic performance" in the semester before tuition.

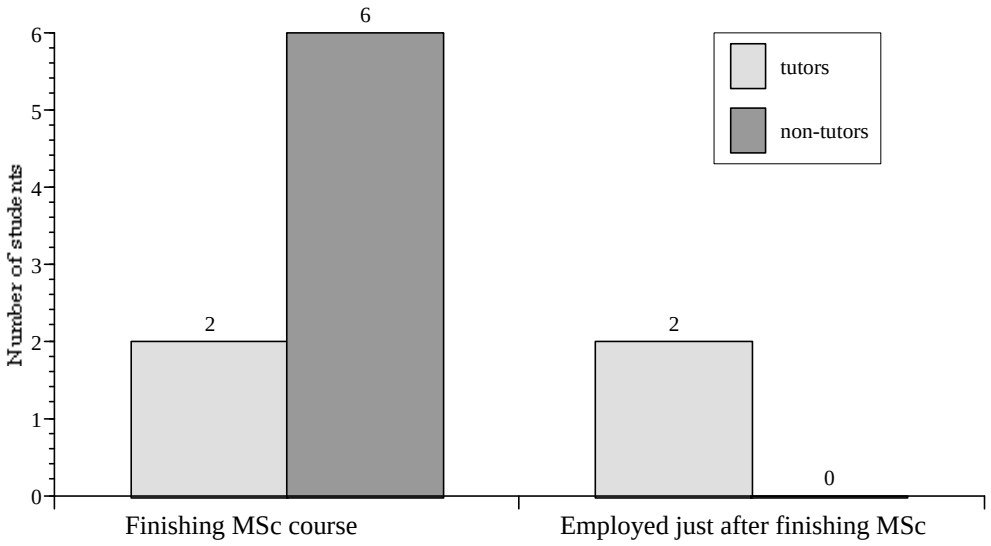

Figure 4. Number of postgraduates getting permanent jobs *immediately after* (not more than two months) the completion of their master degree in Entomology in the Federal University of Viçosa. Analysis was restricted to Master degrees granted in the year of 1998. There is an unconfirmed trend denouncing that postgraduates who have acted as tutors get permanent jobs faster than those who did not took part in the tuition system of the discipline "General Entomology".

it working, each lecturer should allocate one hour every second week in order to check the work with the tutors, plus a few extra hours in the beginning to explain the system for the tutors and the end of the semester, to evaluate the system. All the other activities demanding time are those normally associated with responsible teaching: class preparation, advising students, lecturing itself, and administrating the course. More interestingly, when your postgraduates start tutoring, they experience themselves the horror of being interrupted all the time for unimportant reasons. Thereby, they value much more your time as their adviser, and naturally refrain themselves of interrupting you... As a result, you save time, which can be reverted to work of better quality, which is in the end beneficial for the students themselves.

The sceptic would ask: are our students prepared for such a change? With massification of postgraduate courses it is no surprise to observe an increase of the diversity of reasoning patterns among postgraduate students. Such a heterogeneity could be deleterious to the undergraduate student, who will face different ways of thinking when interacting to the postgraduate. To prevent troubles, we envisaged a self- organized system: in order to ensure academic quality and entomological accuracy, students and tutors were encouraged to check their solutions with the teacher, *after* a primary outcome was achieved. In addition, as we said above, lec-

turers and tutors would meet for one hour every two weeks in order to discuss difficulties arisen. Because such solutions were directly related to the grade to be obtained in the end of the course, students would make sure their solutions were correct, thereby producing a self- organized, error-proof, system. If discussion among students would have provided wrong conclusions, undergraduates would not have improved their grading by attending tutorials (Fig. 2), nor would tutors have improved their overall academic performance (Fig. 3). The point that must be made here is that, regardless of the way the discussions were carried out, the final result is positive: undergraduates and tutors *did* produce right answers in the tests applied to them. In other words, even in the event that tutors were not quite as formally prepared as we lecturers would want, the challenge posed by the discussions with the undergraduates led to positive results.

Another worrying question is related to time schedule of postgraduate students. Would their thesis work get impaired because they "waste" valuable time as tutors? A considerable pressure on abbreviating the time for thesis completion is at stake nowadays and supervisers as well as students are not willing to risk their grants by delaying more than it is tolerated. Some evidences seem to point to an opposite direction. By collaborating with undergraduates to plan scientifically sound and short experiments (item 3 above), many tutors said they were able to improve their own thesis, fixing their hypothesis and, thereby, shortening experiments without losing quality.

Why did students get better grades?

The traditional paternalistic approach arise, no doubt, from the genuine intent of the teachers to improve learning. Paternalism, however is an arid teaching strategy, in a sense that it favours memorization at the expense of reasoning. And it is very long the journey from purely memorizing topics to solving practical as well as theoretical problems (Stice 1976). For instance, it does not help to *list* precisely which are the insect Families presenting four tarsomeres in the hind leg, if one can not *decide* whether such a character should be considered in a phylogenetic analysis of these Families. Or, more agronomically, it does not help to make a full inventory of the insect fauna inhabiting a plantation, if one can not *evaluate* which ones are to be pest in near future. Moreover, simply listening to or repeating something produces "auto destructive" knowledge. That is, knowledge thereby acquired is likely to be stored in such a way that we have difficulty in finding it when we want to remember it (McKeachie 1999). Specifically for Entomology in tropical countries such as Brazil, memorizing list is even more deleterious. Due to the impressive biodiversity, one will always find new species at each inventory, several exceptions for virtually any rule, etc. Therefore, if one was not taught how to think in terms of Entomology, one will face any event as something absolutely new. This is the attitude generating bad professionals: inability to synthesize knowledge is not welcomed by Science nor by Technology, simply because such an attitude does not produce solutions.

Our approach, on the contrary, is based on the idea that what is important is learning, not teaching (McKeachie 1999). That is, we must focus our attention on the students, allowing them to interact with each other in a cooperative way (banning the competitive framework mostly agreed in academia). We believe that the students must think about the subject taught, in order to be able to learn it effectively. Moreover, we believe that the students must be motivated in such a way that they will feel a compulsion to learn more, and will actively search for complementary knowledge. Such a "student-centred instruction" improves knowledge retention and deepness in understanding (Felder & Brent 1996).

It seems, therefore, that students who are reported here to have got better grades, did so because they were able to think about Entomology, by interchanging ideas and discussing questions which demand higher levels of

reasoning ("why" questions). The consequent knowledge retention promoted by such an attitude seems to explain such grades.

Motivation as well as active learning was achieved also by problem solving tasks: by planning and carrying out an small scientific research, undergraduates faced Entomology as it is experienced by Entomologists, and therefore were able to grasp how fascinating it could be. Simultaneously, by advising such small projects, postgraduate tutors faced Entomology as it is experienced by their Supervisors, thereby learning how rewarding (and sometimes bureaucratic!) it could be.

Should we give up lecturing?

It may be wrongly concluded that we believe teaching is unnecessary. On the contrary, active learning as reported here only works if proper guidance is provided by the lecturer. In fact, the system we propose has three necessary components: the undergraduate, the postgraduate, and the lecturer. None of these three can be missed or diminished in value. That is the main issue arising from this article: learning is more profitable if it proceeds cooperatively.

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