A Cooperative Learning Approach to Encourage Active Learning Among Biology Students

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Third teaching cycle

A cooperative learning approach to encourage active learning among Biology students at different levels

Abstract

Research-based learning is becoming increasingly more important given the current interest in research-intensive Universities. Cooperative learning is a useful tool to encourage active learning by mixing students with different abilities in small groups in practical learning sessions. I used a cooperative learning approach in order to increase student participation and active learning by mixing research students at different levels: undergraduates in their last year, MSc students and PhD students. A series of meetings where students, post-docs and visitors discussed their research progress and interests were held weekly over two years and the results were assessed by qualitative questionnaires. The inclusion of undergraduates had to be limited to students taking summer placements due to clashes of the meetings with their timetable. Participation and answers to the questionnaires indicated that the students evaluated the experience as positive, and the suggestions for improvements indicated that students appreciated the inclusion of students/researchers working on different topics. Modifications in the assessment are needed for a better understanding of the learning outcomes of the meetings.
Introduction

In a climate in which Universities are encouraged to be research-intensive, research-based learning should become the main vehicle by which students can build strong links between cutting-edge research and their own learning. Research-based learning is based on problem-solving, cooperative and discovery-directed learning (Klingner 1999). However, despite its recognised usefulness, it has not been widely applied (Lockwood, 1994). Research-based learning is based on using the research process as a tool for knowledge acquisition (Somwang, 1998). In this sense, the advantage of research-based learning is that students have the chance not only to learn concepts but also to practice research-related skills, such as constructing and testing a hypothesis and collecting and analysing data. This experience is particularly highlighted in the research project carried out during the final year of degree course such as Biology. During the development of their projects undergraduate students have their first opportunity to be active researchers. This experience could provide them with the opportunity to be integrated into active research groups, enhancing their learning experience and giving them the chance to assess their own interest in a research-orientated career. However, the integration of undergraduate and even MSc students in active research groups is not common, and in most cases undergraduates and MSc students carry out their projects on an individual basis with no interaction with students/researchers at higher levels. This situation clearly represents a missed opportunity for cooperative learning that can be particularly beneficial for individual learning (Brown & Palincsar 1989; Clark 1997), particularly for the deep-learning type of students.

Cooperative learning represents a teaching strategy which mixes students with different levels of ability in small groups to carry out different learning activities with the objective of improving their understanding of a particular subject. Social interdependence was assessed in terms of postgraduate students' individual orientation (that is, cooperative, competitive, and individualistic). Cooperative learning has been successfully applied at different learning levels, from school to postgraduate students. The success of cooperative learning has been related with
the degree of individualism of the students involved, and in the context of postgraduates, the inclusion of individuals with more individualistic orientation in heterogeneous groups has proved useful for promoting students' active learning (Onwuegbuzie et al. 2009).

In this teaching intervention I used a cooperative learning-like approach in order to promote active learning among a small group of undergraduate and post-graduate students. The intervention was inspired in my own experience as an undergraduate in Biology. During the last years of my degree (a 5-year degree) I volunteered in the Department of Genetics at my University and the regular interaction with PhD students, post-docs and senior researchers was fundamental to encouraging more active learning and greatly influenced my decision to pursue a career in Research. I intended to provide a similar experience to undergraduate, MSc and PhD students by encouraging their attendance at regular research-orientated ‘lab meetings’. Thus, the main objective of the teaching cycle was to encourage the interaction of students at different levels in order to encourage discussion and active participation in the learning process in a research environment.

Learning Outcomes

1. To introduce students at different levels to the specific practices and ethics of Biological Sciences

2. To enhance the student learning experience by exposing them to cutting edge research

3. To develop and enhance students research-related skills such as critical and analytical thinking, information retrieval and evaluation and problem solving

4. To promote cooperative learning between students at different levels
Methods

Regular research meetings (lab meetings) are routinely carried out in many research groups at Universities. Although the format of these meetings varies depending on the extent and background of the group, in general all involve short informal presentations by members of the group about their research and/or about recent publications or scientific advances in the form of “journal clubs”. In general these meetings are held on a periodic basis (weekly, fortnightly or monthly) and usually are only attended by PIs, post-docs and PhD students. Although my research group was initially very small (1 PhD student and 1 post-doc), I started running weekly lab meetings with the intention of keeping us updated on the latest advances in our field and also discussing ‘housekeeping’ matters related to the work in the lab. It was when I started supervising MSc and undergraduate students that I thought about the potential advantages of including them in the regular lab meetings. The objective was twofold: increasing the topics for discussion and increasing the interaction between MSc and PhD students. Given that MSc students only spend 3 months of their degree in research, I reasoned that the interaction with PhD students (who have a research-intensive degree) would be beneficial for them in deepening their research experience. My original idea was to include 3rd year undergraduate students doing their research projects in the lab in the experience, but soon it became clear that their timetable made it difficult. The final structure of the lab meetings that have been running now for around 2 years is:

- All PhD, MSc and undergraduate students in summer placements (2 this year) are invited to attend these weekly meetings.

- The meetings involve a short (~15 min) and informal presentation by a member of the group (including postdocs and PI) on any aspect of their own research (from a new technique or a recently read paper to practicing a talk for a conference or discussing difficulties in the project). The meetings encourage informal discussion after (or during) the talks, where the contribution of the students is intended to be dominant while the role of the PI is just moderation.
- Routine laboratory maintenance matters and problems are briefly discussed in
  the second part of the meeting. This part is intended to make all the students
  aware of their responsibilities in maintaining the lab and the running of the
  group (e.g. cleaning rotas, care of the equipment, cooperation in sharing
  equipment and lab space…)

- Visitors are also invited to the meetings and give a talk about their research (I
  have had several visitors in the last two years including PhD students,
  researches from the private sector and professors, from Spain, Canada and
  Chile).

The evaluation of this teaching cycle was particularly challenging due to the small
size of the group and its inherent transitoriness and the absence of formal
examination related to it. In order to evaluate the effectiveness of the teaching
intervention, anonymous questionnaires were used to assess the students’ own
perceptions of their learning experiences in relation to the lab meetings. The
questionnaires were organised in two sections. The first section consisted of nine
scaling questions (with answer categories ranging from Strongly agree to Strongly
disagree) to assess how the students valued the outcome of the meetings. The
second part was a series of four future-orientated feedback questions intended to
obtain feedback for improving the structure of the meetings.
LAB MEETING QUESTIONNAIRE

For the last two years we have holding weekly lab meetings that include students at different levels (MSc, PhD and occasionally undergraduates), post-docs and visiting researchers. This questionnaire is aimed to assess the utility of these lab meetings and to identify potential areas for improvement. Many thanks for your feedback!

- Joint lab meetings including students at different levels and post-docs

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<tr>
<th></th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>No Strong Feelings</th>
<th>Disagree</th>
<th>Disagree Strongly</th>
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<tr>
<td>Q1. Increase interest in research</td>
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<td>Q2. Encourage discussion</td>
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<td>Q3. Increase communication</td>
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<td>Q4. Are intimidating</td>
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<td>Q5. Broaden students scientific interests</td>
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<td>Q6. Help in preparing talks/seminars</td>
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<td>Q7. Encourage group cohesion</td>
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<td>Q8. Are a waste of time</td>
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<td>Q9. Should include just one student level</td>
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- Mention some positive outputs of joint lab meetings
- Mention some negative outputs of joint lab meetings
- What changes would you make to the lab meetings format that could improve them
- Any other suggestions?
Results

In total nine responses to the questionnaires were received including four PhD students (two of them visitors that stayed for 3 months), three MSc students, and two undergraduates with a summer scholarship. The attendance at the lab meetings was very good; all students at all levels attended most meetings and most absences were due to exceptional circumstances (e.g. clash with lectures, attendance at conferences or illness). The participation in the talks was very good, students from all levels from undergraduate to PhD presented their work and actively participated in the discussions. The order of the presentations was voluntary and all the students participated in the organisation. The results from the scaling questions (Figure 1) indicated that students evaluated the meetings as a positive experience that in general they increased their interest in research. In all cases students considered that the meetings encouraged discussion and communication and did not perceive them as intimidating or a waste of time.

![Figure 1. Distribution of answers to the scaling questions about the outcome and utility of the lab meetings answered by nine students.](image)

Responses to the feedback questions were also very uniform. The main positive outcomes identified by the students were the opportunity to practice talks in a...
relaxed environment, the opportunity to discuss their own research with peers, the chance to meet other students working in a similar area, the broadening of their research interests, and the positive interactions created after the meetings. The main negative points were the discrepancy in objectives between different levels of students and the potential time spent in preparing the talks. Most students did not propose changes to the structure of the meetings; the main suggestions were regarding the inclusion of students in a similar area but from different research groups, in order to further broaden the discussion topics.
Discussion

Here I applied a cooperative-learning strategy to increase active student participation in learning and to enhance the research-learning experience for students carrying out their dissertations at different levels, from undergraduate to PhD. Although the initial intention was to include all student levels in discussion meetings, it proved very difficult to integrate the meetings with the timetable of 3rd year students, thus the undergraduate representation was limited to students working during the summer. The intention of the meetings was not only to enhance research-orientated discussions but also to create an awareness of the need for personal collaboration within research groups. The meetings consisted of informal research talks and brief “housekeeping” discussions where lab maintenance issues were discussed.

Students were particularly enthusiastic in the discussions about research methods and participated actively in all sessions. The more applied parts of the session were useful for discussing some problems related to the different time scales of different students (e.g. 3 months for MSc versus 3 years for PhD) and the different degrees of responsibility expected in terms of group work (e.g. lab organisation or animal maintenance). Students were expected to learn from the process by the active participation of the teacher in their research projects but also by observing and summarising the research results and procedures acquired from their peers (Pateep 2000). In this sense, one of the objectives of the meetings was to create a “team atmosphere” in order to maintain and enrich the development of a collaborative group of people (Solomon, Davidson, & Solomon, 1993). In fact, active collaboration was observed among the students after the discussions of their respective projects during the lab meetings.

Cooperative learning has proved very effective in developing student understanding, when students have a defined role to play (Mazano et al. 2001). The intention of this teaching cycle was to cover the five essential components of cooperative learning (Brown & Ciuffetelli Parker 2009):

1. Active participation and input in the group (positive interdependence)
2. Promotion of interaction by direct collaboration and assistance in others’ success
3. Individual Accountability
4. Social Skills, including communication, decision making and conflict management
5. Group processing and assessment of the effectiveness of the process

During this teaching intervention, four of the five components (1-4) seem to have been achieved, although the results made obvious the need for more accurate assessment. The answers to questionnaires indicated a positive evaluation by the students and a positive involvement in the process (as revealed by the interest in including students from different groups and research interests in the meetings). However, they could not measure the outcomes in terms of students learning progress. More accurate assessment of the results might be obtained by periodic individual interviews, peer-assessment and informal assessment of the dissertation progress at the different levels. Future plans include widening the methods of assessment and including the suggestions of the students in the structure of the meetings (e.g. inclusion of students from different research groups).
References


