Enhancing Bioinformatics and Genomics Courses: Building Capacity and Skills via Lab Meeting Activities

Fostering a Culture of Critical Capacities to Read, Write, Communicate and Engage in Rigorous Scientific Exchanges

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Reading, writing, publishing, and publicly presenting scientific works are vital for a young researcher’s profile building and career development. Generally, the traditional educational curricula do not offer training possibilities to learn and practice how to prepare, write, and present scientific works. These are rather a part of lab meeting activities in research groups. The lack of such training is more critical in some developing countries because this adds to the rare opportunities to discuss and become involved in the exchanges on state of the art scientific literature. Here the authors relate their experience in introducing a weekly 1-day lab meeting in the framework of two previously organized 3-month courses on “Bioinformatics and Genome Analyses”. The main activities which are developed during these lab meetings include scientific literature follow up as well as preparing and presenting oral and written scientific reviews. These activities prove to be useful for a student’s self-confidence building, for enhancing their active participation during the lectures and practical sessions, as well as for the positive impact on running the whole course program. Incorporation of such lab meeting activities in the course program significantly improves the capacity building of the participants, their analytical and critical reading of scientific literature, as well as communication skills. In this work it is shown how to proceed with the different steps involved in the implementation of lab meeting activities, and to recommend their regular institution in similar courses.

Lab meetings are at the heart of scientific life because they provide an exceptional environment for developing skills in team work, networking, exchange on research advances and for enhancing self-confidence and career-building by offering young researchers opportunities to learn how to 1) prepare and present personal research findings; 2) select and discuss challenging papers; 3) develop and hone analytical skills; 4) practice communication skills.

We adapted this concept by incorporating a weekly 1-day lab meeting in the organization of two 3-month “Bioinformatics and Genome Analyses” courses[1] that we organized at the Institut Pasteur Tunis, Tunisia. The course was intended for about twenty selected young Ph.D. students and researchers with backgrounds in Biology, Mathematics, Statistics or Computer Science. It was focused on topics related to bioinformatics, comparative genomics, metagenomics, genome variant analyses and programming in a Unix environment.

In order to foster the participants’ involvement in the lab meeting activities, each participant had to prepare a synthetic review based on some selected bibliographic resources. This “bibliographic project” constituted a significant component of the course outcome, and had to be formally presented at the end of the course. For that purpose, a large number of quality published papers encompassing most of the course topics were specifically collected and passed to the participants. These documents helped the participants to follow the course program and to select adequate papers for their respective projects.

Central activities during lab meetings included work toward preparation of the different projects, follow-up of recent scientific literature, critical reading of papers, review preparation, and presentation, as well as idea-sharing through discussion.

Figure 1 shows the steps that we followed in the development of activities. Four main operational objectives constituted the backbone of the procedure implementing these activities 1) Training on reading scientific literature; 2) Preparation of oral presentation and synthetic reviews; 3) Organizing and leading lab meetings; 4) Final review presentation and evaluation.

In the following we develop the content of these activities and introduce their implementation in the context of the course program.
1. Training on Reading Scientific Literature

One of the main objectives of lab meeting activities was to prompt participants to critically read scientific literature and write reviews summarizing research papers. The two following steps describe how we proceeded.

1.1. Collect Relevant Bibliographic Resources and “Sign in” to Top Scientific Journals

The organizers collected and passed to the participants a large number of pertinent and seminal published articles covering most topics of the course program. They are mainly relevant to: genome sequencing technologies, genome assembly, gene prediction methods, genome analyses, whole genome alignments, genome structural variants, phylogenomics, metagenomics, systems biology, synthetic biology, microbiome, giant viruses, genome resources, main genome sequencing projects and studies of specific genomes. Participants had to identify the core papers to consider for their bibliographic projects.

For the follow-up of weekly published scientific literature, the participants had to “sign in” to receive alerts from some scientific journals that traditionally publish works related to the course topics, so as to regularly receive their respective Table Of Contents (TOCs). Examples of suggested journals included: Science, Nature, Nature Genetics, PLoS Computational Biology, PLoS Genetics, BMC Genomics, etc.

1.2. Choosing “Bibliographic Projects”

The “bibliographic project” consisted of synthesizing the contents of about five selected papers relevant to a given topic. Projects aimed to foster participants to develop 1) good habits of critically reading scientific literature; 2) ability to synthesize and summarize the content of scientific works; 3) prepare and orally present this synthesis.

Examples of suggested topics included: genome assembly methods, genome alignment algorithms, orthologs inference and clustering, tree of life construction, methods for genome structural variant analyses, gene and Genome editing. A formal talk and a written review were the final outcomes of the project, as presented at the end of the course.

2. Preparation of Oral Presentation and Synthetic Reviews

Participants had to train on how to prepare oral presentations, content and form, as well as on how to write synthetic reviews. The following three steps show how we proceeded.

Regularly receiving TOCs of such high-quality scientific journals should develop habits of reading scientific literature and enhance the participants’ awareness of progress and novelty in science.
2.1. Talk Preparation and Progress Presentation

Students had to present visuals showing the progress in their respective bibliographic projects. They were assisted on how to decide what to include and the logical plan to consider for the slide contents.

2.1.1. Decide What to Include and the Logical Plan to Consider for the Slide Contents

We suggested using succinct and clear sentences in every slide, and preparation of a logical flow according to referenced literature: a few comments about the reasons for choosing the project topic (beginning); a plan for the talk, followed by the development of the important and striking ideas (middle) and finishing with a few slides indicating the take-home message (end).

2.1.2. Give a Talk During Lab Meetings

Participants were prompted to outline clear and logical ideas. They had to state the content of their analyzed papers in a concise presentation and to stick to the conceptual organization of their prepared slides, respecting the above-mentioned suggestions.

2.1.3. Face-to-Face Discussion and Comments in an Informal Atmosphere

Feedback from colleagues including positive comments as well as discrepancies and inconsistent parts of the talk, helped to improve the presentation content. This interaction also reinforced the cooperation and solidarity between the participants as well as their self-evaluation.

2.2. Review Preparation and Progress

Bibliographic reviews aimed to foster critical reading of papers, writing of synthetic reports, fairly acknowledging references and consequently developing one’s own analytical skills. From these reviews, we expected synthetic insights useful for all participants, promoting knowledge dissemination by way of scientific enrichment.

Participants were suggested to take notes while reading, by writing down essential sentences and ideas; list the major results achieved and methods used; point out any further outstanding question that needed further clarification; collect these notes to help write the first draft of the review; rewrite, structure, and rethink the first drafts using one’s own words to improve the quality of the review; favor integrative final review focusing on common ideas, concepts, and methods from the reviewed papers; carefully plan a logical structure for review writing as well as for the oral presentation, making sure that all important ideas were logically reported without repetition; follow a plan consisting of a general introduction explaining the choice and the context of the topic, recapitulation of the main results, ideas, and methods covered in the reviewed papers and a conclusion including take-home messages and perspectives; avoid plagiarism by including only one’s own text and illustrations.

2.3. Paper Selection from TOCs and Presentation

The participants had to select at least one paper from the TOCs received during the week that could be of interest to the audience and possibly discuss and comment on them.

The objectives were to train participants to 1) be aware of current developments in bioinformatics and genomics; 2) develop habits of regularly reading and seeking recent scientific literature; 3) Summarize the content of such papers; 4) Prepare and present a visual document reporting their synthesis.

Selected papers from TOCs were presented and discussed including, if necessary, the cited references so as to clarify the progress that led to actual results and knowledge. It was interesting to note the diversity of selected papers during each week and the consequent collective enrichment for all participants.

Examples of commented papers from TOCs included: genome editing, sequencing methods and tools review celebrating the 40 years of Sanger sequencing techniques, a new genome assembly method and tool, ancient genome analyses and news about retracted papers (detailed lab meeting activities in https://webext.pasteur.fr/tekaia/BCGAIPT2017_BCGAIPT2017_Prog.html, https://webext.pasteur.fr/tekaia/BCGAIPT2018_BCGAIPT2018_Prog.html).

TOCs follow-up was helpful to keep the participants continuously immersed in the course atmosphere, to stay on top of the literature, to regularly discover contents of recently published works and to encourage the selection of challenging papers to read carefully and commit to discuss and comment during the next lab meeting.

3. Organizing and Leading Lab Meetings

Projects preparation and presentation often triggered discussion that had to be initiated and coordinated by experienced leaders.

3.1. Develop Scientific Exchange and Argumentation Skills

Argumentation and discussion are key processes in learning and assessing new ideas and concepts. Participants were encouraged to commit themselves to commenting, questioning about topics and ideas introduced during projects and paper presentations as well as during lectures and practical sessions. We emphasized the importance of speaking, listening and involvement in argumentation as a means for learning and developing analytical skills.

Although lab meeting activities favored an informal atmosphere, participants were asked to state claims and provide evidence in an organized way that allowed them to express opinions and also to listen to others. All of this had a positive impact on improving project presentations.
3.2. Lab Meeting Organization Frequency

Regularly organizing lab meetings was important for continuously keeping alive participants’ interest and attention. The set-up of 1 day per week for lab meetings was mainly suggested by the regular progress-checking of bibliographic projects and by the weekly availability of TOCs. A whole day was also needed to allow participants to show their project progress and to reasonably intervene without time constraint by suggesting ideas, explanations, questions, and comments. Moreover, we had to stress the importance of these activities as a significant part of the course program.

3.3. Leading Lab Meetings

Lab meetings were organized with no stringent rules about the timing, content, and discussion, but for better efficiency we opted to have the activities led by two senior scientists respectively experienced in Biology and in Bioinformatics. Leadership was critical for multi-intervening participants with diverse backgrounds to run the meeting properly and keep it at once time-friendly, open, and flexible.

A significant role of the leading scientists was to assist participants in efficiently reading and synthesizing publications, preparing and delivering oral presentations as well as to emphasize open discussion and idea-sharing, and to ensure that everyone took part effectively in this organization by encouraging some to ask questions/make comments, and others to slow down their interventions.

Senior scientists had to guide the participants in critically reading recent publications, particularly highlighting the gradual evolution of technologies and advances. They had to pay attention to the logical reasoning and to suggest further reading of appropriate references, if needed, including seminal articles or primers providing historical perspectives and context that made easy reading of recent papers. Also, they had to guide participants in rigorously reporting papers’ contents by concentrating on the course topics: Bioinformatics and genomics, avoiding, on the way, improvisation and attempts at diversion.

Instructions on respecting ethical rules and scientific integrity, for example, excluding plagiarism and insistence on scientific rigor, benefitted from analysis of published news features about article retractions.

Other contributions included the participants’ preparation to communicate well-structured oral and written documents and to develop argumentation skills about concepts and topics reported in lecture presentations throughout the course period.

4. Final Review Presentation and Lab Meetings Evaluation

During the last week of the course, final reviews of the bibliographic projects and corresponding talks were formally presented. It was interesting to note the progress made by all participants in their presentations (form and content) as well as the acquired self-confidence they showed during the talks and the questions/comments sessions.

At the end of the course, participants evaluated the whole course program including lab meeting activities. The general impression was that participants positively appreciated these activities.

In Conclusion our experience showed the importance of including lab meeting activities in a Bioinformatics and Genome Analyses course program, and thus particularly to follow up and read scientific literature as part of the educational outcome of such a course. Rigorous discussion and exchange on scientific advances were significant components of such activities. They were essential means of training young researchers, instilling in them novel scientific awareness about ethics and scientific integrity as well as self-confidence building.

Lab meetings significantly complemented the theoretical and practical parts of the course by introducing team working and communicating on scientific topics and constituted a collective enrichment by the collected presentations through the TOCs and bibliographic reviews. This studious atmosphere positively impacted the rest of the course program, enhancing active participation and even making the teaching task easier.

Finally, we recommend fostering lab meeting culture in similar courses, so that young researchers can develop critical capacities to read, prepare, write, communicate and engage in rigorous exchange of scientific information.

The diagram shows the steps that are grouped into four main operational components. 1) Training on reading scientific literature; 2) Preparation of oral presentation and synthetic reviews; 3) Proceeding and leading lab meetings; and 4) Final review presentation and lab meeting evaluation.

Key words characterizing respective activities and recommendations of each step are listed.

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Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Both authors read and approved the final manuscript.
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