17

Opening sessions (OS): A tool to facilitate bioinformatic digestion in dry-laboratory exercises

Josue L. Castro-Mejía

Department of Food Science
University of Copenhagen

Summary. Finding alternatives techniques to facilitate digestion and consolidation of knowledge derived from distinct scientific disciplines is an important task of interdisciplinary teaching. During a master course that enrolled 63 individuals, we aimed at evaluating the integration of opening teaching sessions (OS) and their impact on formative assessment and student satisfaction.

Integration of OS significantly increased the acquisition and usage of elementary bioinformatic concepts/skills, which was evaluated throughout inquiries for formative teaching. Furthermore, application OS corresponded with a high level of satisfaction possibly by driving instructional effectiveness and student centeredness.

Keywords: opening sessions, electronic voting system (EVS), formative assessment, student satisfaction

Introduction

Between September and November 2019, the section for Microbiology and Fermentation at Department of Food Science held the Master Science Course entitled “Microbiology of Fermented Foods and Beverages” (MFFB), in which 63 students were enrolled. The course structure included lectures, wet- and dry-laboratory exercises, theoretical exercises and case studies. In this course over 10 teachers were involved, including professors/associates, postdocs and PhD students. Most of the activities related to lectures and wet-laboratory exercises have been extensively optimized within the last 5-10 years. However, when dealing and focusing on dry-laboratory exercises (data analysis), particularly in the analysis of molecular biology results, the interpretation of data can become a tedious, slow and frustrating process for students and teachers. Courses like MFFB and similar require students to rapidly acquire an intermediate level of proficiency with a number of bioinformatic software, online tools and databases. In its current form, rather than allocating most of the exercise's time for analyzing and interpreting the results obtained throughout wet-laboratory experiments, students often straggle the most with (i) understanding basic technical concepts and (ii) for running a given software/tool/database. A possible solution to this would be to implement a new course within the study program to address the aforementioned issues, but this may not represent the most viable solution given a number of inherent limitations. Alternatively, another way to deal with this challenge could be to implement opening teaching sessions (OS) (before the beginning of the exercise) to coach bioinformatic (technical) concepts related to the questions and challenges of the exercise. Under this new setup, students would not only spend less of their time learning tools usage and searching for sites of accurate information, but rather allocating time for problem formulations and interpretation of results derived from problem-based projects (Krogh & Wiberg, 2015) that are previously developed in wet-lab activities. From a pedagogical perspective, it can be pointed out that this approach may be able to foment longer periods of formative feedback and interactions. This could promote constant dialogues between students-students (within and between groups) and students-teacher (Rienecker & Bruun, 2015), which may ultimately lead to the arouse of critical thinking among the study participants. With this in mind, the aim of this project was to evaluate the integration of OS at the beginning of dry-laboratory exercises (DL-Exercise) from two angles. The first was focused on testing the efficiency for acquiring elementary concepts and skills on the basis of OS by formative assessment (Couto et al., 2019; Rienecker & Bruun, 2015). The second angle was focused on measuring the level of students' satisfaction (Elliott, 2002) in relation to the implementation of OS. To accomplish this, we applied online tools based on an electronic voting systems (EVS), commonly known as "clickers", which in previous years have been demonstrated to be an efficient tool for optimizing students' engagement and learning (Balta & Tzafilkou, 2019; Mathiasen, 2015). In this project, the application of EVS allowed to gain knowledge on efficiency of formative feedback and the students' satisfaction.

Methods

Implementation of short opening sessions

Up to 48 students participated in two DL-Exercises (Figure in appendix A), representing 76% of the registered students in the course. In our experimental setup, DL-Exercises I and II were performed in two independent days and relied on problem-based projects previously developed in wet-lab activities according to the course plan. A teaching opening session (OS) with a duration of 30 min was integrated exclusively in DL-Exercise I, where a general overview of the exercise program and basic knowledge in bioinformatics (e.g. blast algorithm, indels, id, alignment, etc.) (Figure in appendix A) was delivered. Formative assessments were implemented in DL-Exercises I and II, while a satisfaction survey was carried out only at the end of DL-Exercise I (Figure in appendix A).

Electronic Voting System (EVS)

Licensed EVS platform based on the Socrative application (socrative.com) was used during the short opening sessions (OS), for both formative assessment and satisfaction evaluation. Data on formative assessment was collected as technical questionnaires of multiple-choice, while for student-satisfaction data were collected through a binary questionnaire.

Statistics

Significant differences in the distribution of students proving accurate/inaccurate answers as a measurement of concept and skill acquisition were evaluated through Chi-square test as implemented in R (v. 3.6.0).

Results

Students perform best in formative assessments when opening sessions are integrated

To test whether opening sessions (OS) could increase the acquisition of concepts and skills throughout DL exercises, we applied an informal formative assessment by means of EVS. Students were exposed to two questions at different stages of the exercises. The aim of these questions was to evaluate learning needs and problems, as well as to develop a stronger understanding of their own strengths and weaknesses of their problem-based scenarios. It is important to clarify though that that the questions asked to the study participants were typical inquiries applicable at any time under the course examination. This includes, e.g.

"You managed to get a bacterial isolate and your gut feeling tells you it's a Lactobacillus spp., but you're not sure. Thus, you decide to amplify the 16S rRNAgene and send the amplicons (products) to Macrogen for sequencing. After two days turn around, you finally get the sequences and you blast them against NCBI. What bacterial specie have you isolated?

A) *Lactobacillus plantarum* (%Identity: 99, %Query-Cover 99.3, e-value: 0.0)
B) *Lactobacillus pentosus* (%Identity: 99, %Query-Cover 99.3, e-value: 0.0)
C) The isolate belongs to either *Lb. pentosus* or *Lb. plantarum*, but I cannot discriminate them based on 16S rRNA.
D) The database is wrong and cannot trust the results!"

The results of this intervention revealed that when OS was integrated (DL-Exercise I) over 85% of the evaluated study participants were able to correctly answer applied questions related to the molecular biology subject of topic (Figure in appendix B). On the contrary, when opening sessions were not incorporated (NOS) (Exercise II), the proportion of students that accurately answered questions was more variable and significantly decreased as compared to those obtained through OS (Figure in appendix B).

Students consider short opening sessions (OS) as an important component for future courses

At the end of the exercise in which OS was integrated (DL-Exercise I) students were asked to evaluate the importance of OS in their learning. Thus, this was evaluated on the basis of a binary question on EVS that could gather a closer answer to their own perception. Here, a vast majority (accounting 97%) of students expressed that the use of OS allows them to gain and/or re-assure knowledge needed to accomplish problem formulations and results interpretation in their projects (Figure in appendix C). Furthermore, only 3% of the students declared that they did not obtain relevant information from OS, as their knowledge was already high enough (Figure in appendix C).

Discussion

Given to the rise of interdisciplinary approaches to which applied courses are being subjected, institutions of higher education are dealing with challenges associated with cognitive mindset and limited resources (MacLeod, 2018). Therefore, finding alternatives to facilitate fusion and digestion of several scientific disciplines in a time and cost-effective way is becoming an imperative task. In this project, we aimed at implementing an alternative solution to reduce the gap between food science students and their knowledge in bioinformatic concepts, which in previous years has generated a lot confusion in a number of courses at the department of Food Science. Yet, although the application of bioinformatic concepts and tools have been commonly applied within several areas of Food Science, students at this department are not regularly exposed to the field of bioinformatics.

During our master course (MFFB), where 63 students from various backgrounds were admitted we decided to test the implementation and acceptance of short opening sessions (OS) in bioinformatic background prior DL-Exercises. Throughout the exercises and by means of formative assessment, we observed a significant improvement in the acquisition and usage of elementary concepts and practical skills on the basis of OS. Based on our results we cannot conclude or speculate whether OS had significant and positive influence on the final students' grades. However, in recent similar approaches, it also been shown that application of assessments test and formative assessments in tutorial sessions correlated positively with summative assessments and progress tests (Bestetti et al., 2017; Couto et al., 2019), which reinforced ultimately the problem-based learning.

The application of OS in our setup resulted also in high level of satisfaction among the study participants, where over 95% of the proportion of students expressed that OS allowed to gain and/or re-enforce their knowledge. The application of innovative approaches may not always be associated with improved satisfactions among institutions of higher education (Serdyukov, 2017). However, in connection to our results, it can be speculated that the high level of satisfaction obtained may be linked to instructional effectiveness and student centeredness as key determinants of their satisfaction (Elliott, 2002).

Last, but not least it is also important to point out the importance of EVS as a central tool to retrieve quantitative information from interventional teaching studies (Faya Cerqueiro & Martin-Macho Harrison, 2019). As knowledge facilitators we often benefit from such clickers by either promoting student's activation or driving a convenient approach towards formative teaching. Furthermore, by adequately formulating questions, teachers can get an overview of students acquisition of concepts and skills, session weaknesses and strengths.

References

Balta, N., & Tzafilkou, K. (2019). Using socrative software for instant formative feedback in physics courses. *Education and Information Technologies*, *24*(1), 307–323.

Bestetti, R. B., Couto, L. B., Restini, C. B., Faria Jr, M., & Romao, G. S. (2017). Assessment test before the reporting phase of tutorial session in problem-based learning. *Advances in medical education and practice*, *8*, 181.

Couto, L. B., Durand, M. T., Wolff, A. C., Restini, C. B., Faria Jr, M., Romao, G. S., & Bestetti, R. B. (2019). Formative assessment scores in tutorial sessions correlates with osce and progress testing scores in a pbl medical curriculum. *Medical education online*, *24*(1), 1560862.

Elliott, K. M. (2002). Key determinants of student satisfaction. *Journal of College Student Retention: Research, Theory & Practice*, *4*(3), 271–279.

Faya Cerqueiro, F., & Martin-Macho Harrison, A. (2019). Socrative in higher education: Game vs. other uses. *Multimodal Technologies and Interaction*, *3*(3), 49.

Krogh, L., & Wiberg, M. (2015). Problem-based and project-organised teaching. In L. Rienecker, P. S. Jørgensen, J. Dolin, & G. H. Ingerslev (Eds.), *University teaching and learning* (1st ed., pp. 215–227). Samfundslitteratur.

MacLeod, M. (2018). What makes interdisciplinarity difficult? some consequences of domain specificity in interdisciplinary practice. *Synthese*, *195*(2), 697–720.

Mathiasen, H. (2015). Clickers. In L. Rienecker, P. S. Jørgensen, J. Dolin, & G. H. Ingerslev (Eds.), *University teaching and learning* (1st ed., pp. 281–288). Samfundslitteratur.

Rienecker, L., & Bruun, J. (2015). Feedback. In L. Rienecker, P. S. Jørgensen, J. Dolin, & G. H. Ingerslev (Eds.), *University teaching and learning* (1st ed., pp. 259–280). Samfundslitteratur.

Serdyukov, P. (2017). Innovation in education: What works, what doesn't, and what to do about it? *Journal of Research in Innovative Teaching & Learning*.

A

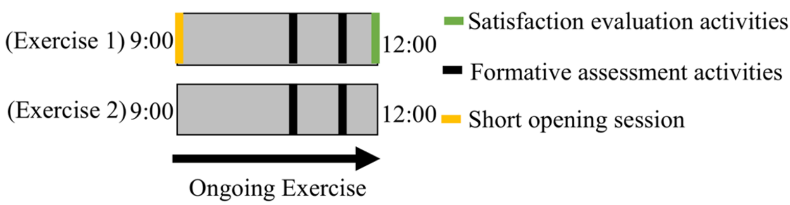

Fig. 17.1. Setup of OS implementation in DL exercises.

B

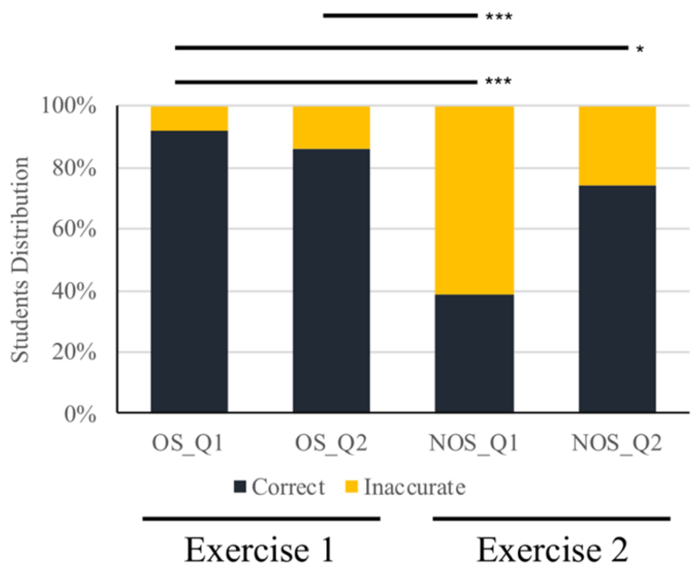

Fig. 17.2. Summary of formative assessment in dry-laboratory (DL) -Exercises where Opening Session (OS) or non-Opening Sessions (NOS) were provided. For every DL exercise, two technical questions (Q1 and Q2) to determine whether specific concepts and skills were acquired and understood. Technical questions were presented to students in a multiple-choice fashion through EVS. Significant differences in the proportion on answered questions (correct/inaccurate) were carry-out with Chi-square.

C

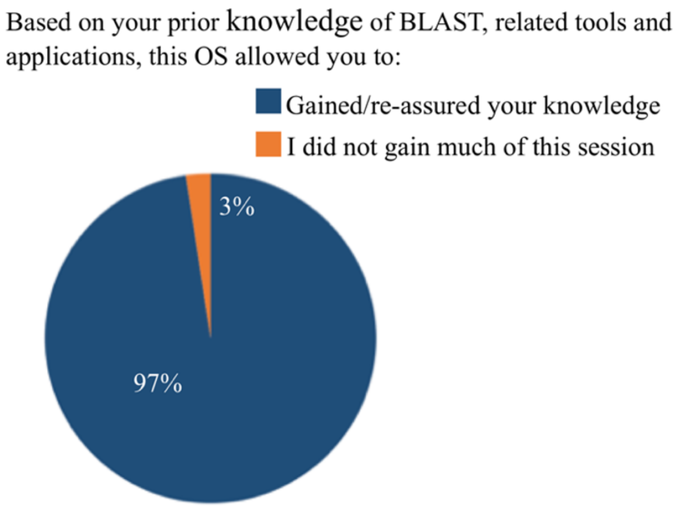

Fig. 17.3. Distribution of study participants in relation to their satisfaction after integrating OS in DL exercises.