

Redesigning the Way Basic Biostatistics Is Trained to the Undergraduate Degree in Aquatic Sciences: A Blended Learning Approach

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Abstract — The undergraduate degree in Aquatic Sciences was reformulated recently according to the Bologna Process. As in any other degree in applied biology, students are required to satisfy a biostatistics requirement. New educational technologies such as Moodle are available in the University of Porto as a tool to promote the blended learning experience among the academic community. This was an excellent opportunity to change the learning process. In redesigning this course, the classical programme in basic biostatistics was maintained but emphasis was given to the problem solving component. The exposition to small biological problems explored both theoretical and practical aspects of biostatistics, including verbal and written communication. A final assignment with the collaboration of researchers from the Centre of Marine and Environmental Research (CIIMAR) gave them a first insight into the professional world in the Aquatic Sciences area. A Forum gave the opportunity to contact the teacher whenever necessary, to ask questions about the assignments and exam, but was also a way to involve students in the learning process. The success achieved with this experience of blended learning has shown its potential in teaching different biostatistics courses.

Index Terms — Aquatic sciences, Biostatistics, Blended learning, Bologna process, Learning process

1 INTRODUCTION

The undergraduate degree in Aquatic Sciences was reformulated recently according to the Bologna Process. This degree was created in 1981, in the Institute of Biomedical Sciences Abel Salazar (ICBAS), a medical and biosciences higher education institution integrating the University of Porto. The course of Biostatistics was moved from the first to the second academic year, and since the degree has a modular structure the course takes place in five weeks instead of the traditional semester. The course corresponds to 5 ECTS.

Following the new challenges that the Bologna Process brought as well as the change of the course from the first to the second year of the degree, the training methods of basic biostatistics should be redesigned.

Although the teacher should continue to impart theoretical knowledge, students should

know assume the responsibility for their own learning process. The role of the student should gain importance in his pathway to knowledge, with teachers being their tutors in this process [3].

At this time it is essential to define new teaching and learning strategies which meet the new educational paradigm. The use of an e-learning platform has proved to be a great working instrument for teachers and students. Therefore the aim of this study is to present the redesign of Biostatistics course of the undergraduate degree in Aquatic Sciences with a blended learning approach in the academic year of 2008/2009.

2 METHODOLOGY AND ANALYSIS

In redesigning the course of Biostatistics the classic programme of basic biostatistics teaching was maintained but emphasis was given to the component of solving practical problems. In this sense, it was thought that the use of a platform for e-learning would allow better monitoring of students work

A problem solving component was developed so that learners not only acquire theoretical knowledge but also acquire competencies in the practice of biostatistics analysis with an insight into the world of work [3] in aquatic sciences area.

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So in the academic year of 2008/2009 it was decided to use Moodle platform - the Virtual Learning Environment (VLE) available at the University of Porto - as a tool to support the presential classes. The intention was to use this platform to (1) explore and improve the skills of students by promoting the involvement in the learning process, (2) assign tasks that create habits of hard work, (3) allow a closer monitoring of their learning process by the teacher, (4) promote an active communication beyond the face-to-face classes and (5) provide diverse study materials.

2.1 Face-to-face Classes

The focus of the course was on basic biostatistical methods rather than on mathematical proofs. Emphasizes in both theoretical and practical sessions were in the interpretation and transmission of results.

In the theoretical component of the course the basic concepts of each topic of the study programme were exposed, using examples in biological sciences. The statistical methods selected were explained to students, but not its mathematical demonstration. Teaching was concentrated on ensuring that students understood the basic statistical concepts, reinforced by means of problem solving, students should be able to define the objective of the analysis, justify the statistical procedure considered and interpret the results obtained. The programme can be divided in descriptive statistics, probability distributions and inferential statistics. The following modules were included in the programme: Descriptive Statistics, Statistical Inference with Quantitative Data, Statistical Inference with Categorical Data, Linear Regression and Analysis of Variance. Inferential statistics included estimation and hypothesis testing and the statistical methods considered were t tests, qui-square test of independence, qui-square test of goodness-of-fit, linear regression, one-way and two-way analysis of variance. Non parametric tests such as Wilcoxon signed-rank test and Wilcoxon Mann-Whitney test were also addressed.

In the practical component the students resolved several problems, with emphasis on the correct formulation of the statistical problems proposed and in the interpretation of results. The application of the statistical methods was done with the aid of a statistical program. The Statistical Package for Social Sciences (SPSS) was the statistical program chosen, since it is easy to use and has the main statistical procedures needed. SPSS is available in the computers of the campus and

the license of the University of Porto allows the students to install this software on their personal computers.

2.2 A Blended Learning Strategy

Since 2003 the University of Porto seeks to encourage the use of Information and Communication Technology (ICT) among the academic community, especially the introduction of an e-learning component that supports and complements the traditional and necessary face-to-face classes – a blended learning model. It is through the Office of Support for New Technologies in Education (GATIUP) that the University is represented to promote and disseminate the use of new technologies and digital content in higher education, including the use of e-learning as a pedagogical tool for teaching and learning.

It is in the academic year of 2008/2009 that was decided to introduce an e-learning component in basic biostatistics, complementing by this way the traditional presential classes (theoretical and practical) with a virtual platform which allows extending the classroom beyond the usual barriers of space and time. The VLE considered was Moodle (Modular Object Oriented Dynamic Learning Environment), the platform supported by the University.

In addition to serving as repository of documents, through the so-called "Resources" that allows the teacher the delivery of diverse materials to support study (general information about the course, presentation of lectures, exercises sheets of practical classes and data files for analysis), the Moodle platform was used mainly to monitoring the learning journey of students through interactive tools like forums and assignments, also called "Activities". The use of this e-learning platform helped creating habits of hard work in the students and allowed the development of the necessary skills for their future career: dynamism in the research; analysis and systematization of scientific information; improvement of oral and written communication; critical analysis about statistical problems; team work; and others.

Since the beginning the use of this blended learning strategy has showed many advantages for both students and teacher. From this combination (face-to-face classes and a VLE) emerged advantages such as:

1. Greater collaboration and sharing of ideas between all participants;
2. Easy access to study materials;
3. Open communication between all the participants;
4. Easy delivery, submission and

- evaluation of assignments;
5. Better monitoring of student progress.

2.2.1 Forum

The forum was the activity that supports the virtual communication between the students and the teacher. Students started using this activity just after the course started. During the course the forum was mainly used to post questions about the assignments, but also as a tool to deliver some material, such as scientific papers.

Some of the students seemed to be more comfortable in this virtual communication environment than in the face-to-face classes. The forum made students more involved in the learning process. Some issues were only addressed by the teacher after being raised by the students. Some examples concern questions about assumptions of the biostatistics methods, graphs or statistic measures adequate for the type of data and problem they were analyzing. The number of messages increased in the days preceding the deadline of the assignments (weekend and Mondays).

Since replying to the questions addressed by one of the students could benefit all the students, the answers were carefully written. Although replying resulted in greater workload to the teacher, by using this tool students did not have to wait for a meeting with the teacher. The forum allowed an easy and fast interaction between both sides, not limited to the communication in the physical classroom.

2.2.2 Assignments

During the course the activity that was more useful and explored by the teacher was the assignment tool. The assignments were all submitted and evaluated through Moodle. We can differentiate the assignments in three types: weekly assignments, final assignment and final exam.

Weekly Assignments

Weekly assignments were the first exposition of students to applications of biostatistics in biological problems. The resolution of these weekly assignments, in a format similar to a short scientific paper, intended to develop their written skills. Students had to report effectively both statistical and biological concepts, involved in their assignments.

All the weekly assignments were made at group level and consisted in a small biological problem with a data file and a submission deadline. Students should be able to construct

a document including five sections: Introduction, Methods, Results, Discussion and Appendix. The Introduction should provide the scope, purpose and rationale of the study. The Methods section should identify and describe the statistical methods, considering the necessary assumptions, state the statistical significance level considered and specify the computer program used. In the Results section, students should be able to report adequately the important trends and main results observed in their data analysis. In the Discussion section they should indicate the interpretation of the main results and the conclusions. In the Appendix students should include the outputs from the statistical program corresponding to the statistical analysis considered in the work, all statistical tests performed including: identification of the statistic method, null hypothesis, alternate hypothesis, significance level, test statistic, degrees of freedom, p value, and conclusion about rejecting or not rejecting the null hypothesis. The Appendix gave detailed information about the application of the statistical tests performed. This information enabled the evaluation of the assignment in terms of application of the statistical tests considered.

Each group had access to their weekly assignment on-line through the Moodle platform, and this was also the way they submitted the resolution and received their evaluation. The evaluation always included a grade and detailed comments about the statistical analysis and the written text. Assignments were graded as Excellent, Fair or Poor. If the statistical analysis was not appropriate, the evaluation would be Poor. Fair was considered for those assignments with some mistakes in the statistical analysis and/or in the interpretation and presentation of the results. Excellent was the grade considered for those assignments with an adequate statistical analysis and correct report of the results with the format of a short scientific paper.

Some the assignments revealed inability of the students to do a correct application of the statistical methods considered and also revealed difficulties in the writing of the report. In order that the students could be able to do a report based in an adequate statistical analysis, with an adequate format, some of the weekly assignments corresponded to the reformulation of the previously submitted assignment. In this reformulation students had to take into account the feedback provided by the teacher previously.

Gradually the students revealed to be able

to define a background and a main objective and report the results obtained through a statistical analysis according to it.

During the implementation of the assignments the students were encouraged to contact the teacher through the forum. By asking questions through the forum they were able to share their doubts and knowledge with the colleagues and at the same time to get a faster answer from the teacher.

Final assignment

The final assignment was considered as a first contact of the students with a “real” problem in the scientific area of aquatic sciences. It was meant to provide students with a perspective on their future skill needs in the applications of biostatistics, so that they gain insight and motivation [2], [3] in this first experience in research. A “real” problem in aquatic sciences should help in the development of skills in the communication of both statistical and biological concepts. The teacher in biostatistics could be the primary advisor of the methodological issues, but researchers/teachers in aquatic sciences could help them in the correct formulation of the aim and objectives of the problem and in the interpretation of the results [2].

At the end of the course the groups had to submit a report with a format similar to the weekly assignments, but as a full paper, and also had to do an oral presentation.

Before the course started the teacher sent an email to all the other teachers of the undergraduate degree and all the researchers from the Centre of Marine and Environmental Research (CIIMAR), asking for collaboration. However the necessary contacts with these teachers or researchers, the definition of the biological problem, as well as obtaining the corresponding data file was the responsibility of the groups.

The submission of the proposal of the final assignment, as well as the final report and the file corresponding to the oral communication was made through the Moodle platform. As in the weekly assignments this was also the way the teacher considered to provide the grades and comments.

Almost all groups succeeded and submitted the final assignment and presented it as an oral communication. The final assignments were mainly based in data provided by researchers from CIIMAR.

While doing their assignments, students considered descriptive statistic analysis and the inferential statistic procedures considered in the course programme. Dealing with “real” data was also an opportunity for students

dealing with numerical problems and developing their skills in biostatistics.

Although the groups were heterogeneous, the majority (7/9) had an Excellent or Fair evaluation in the final assignment, only one had a Poor evaluation and also one of the groups did not submit the assignment.

Final exam

A final exam requiring the same skills necessary for the resolution of the weekly and final assignments was considered. For the examination the students were allowed to consult the materials provided by the teacher. The examination was carried out in computers in which the students could only access the Moodle platform - Internet access was blocked to other pages -, a text editor (Microsoft Word) and a statistical analysis program (SPSS).

The final exam was made to evaluate all students individually as a way to take a closer view of knowledge assimilated by each, since the other assignments were made at group level and sometimes they didn't give a real perspective about the knowledge and skills of each student. The final exam revealed that individual evaluation was needed because students from the same group had quite different marks. After the evaluation of the exam it was clear that some of them seem to be more capable than the others from the same workgroup. Some of the students failed the first evaluation but after the second exam, only three out of twenty-two evaluated students failed the Biostatistics course. These three students belonged to groups that did not submit all the weekly assignments or that had a Poor evaluation in some of them.

3 CONCLUSIONS

In order that education and training systems remain competitive, courses must be planned considering ICT, widely available at universities and at home. Implementation of educational technology, such as the Moodle platform, forms a background against which innovation in the training programmes and evaluation methodologies can be easily achieved [3], [4].

In the undergraduate degree in Aquatic Sciences a new training approach was considered in the Biostatistics course. In this blended learning approach the main objective was to motivate students to develop not just the theoretical knowledge in basic biostatistics but also the competencies required for their future careers.

The delivery of assignments based on practical problems of "real life" was the way found to give them a perspective of the skills they will need in the future in their professional environment [2], [3].

The involvement and cooperation with teachers/researchers in the scientific area of their degree, helped students to communicate effectively about both statistical and biological concepts [2], and improved students awareness of the growing importance of biostatistics in biological sciences.

The forum provided the opportunity for communicating with the teacher in a flexible way, overcoming the usual difficulty of time and space to schedule a meeting in the institution [1], [3]. Perhaps due to the experience that nowadays young people have with information and communication technology [3], students widely used the forum for on-line communication with the teacher.

Individual evaluation was needed since students did their assignments at group level. The final exam required the same skills necessary for the resolution of the assignments. Among the evaluated students, a high rate of success was achieved, with 86.4% of students succeeding after considering the weekly assignments, final assignment and final exam, with the constraint that each student would fail the course if the grade in the exam was less than 7.5 in 20.

After this experience and taking into account the results, despite initial difficulties and the time spent by the teacher in the organization of contents, production of materials and management/monitoring of the activities of students, it appears that the use of a virtual environment is an excellent way to

complement the traditional teaching and learning process. However, it is important to note that the use of an e-learning system do not automatically guarantee approval of the student or the success of the curricular unit [4] and do not replace the role of the teachers.

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