Establishing A Research-Teaching Nexus In Genome Informatics

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Abstract

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1 Introduction

There is a fast growing need for graduates with genomics and bioinformatics skills. To open new career avenues for students and provide skills and experience in these areas, a new 2nd Year undergraduate course "Bioinformatics and Functional Genomics" was introduced into the University of Newcastle Bachelor of Biomedical Sciences degree program in 2005. The course helps students acquire experience in using online bioinformatics databases and tools to solve genomic and other biological problems and inform hypothesis generation and research. It covers basic genomics and bioinformatics including strategies for finding genes and similarities and inferring homologies, microarray analysis and molecular interactions and introductory protein structural modeling and proteomics as well as simple introductions to evolutionary genomics, linkage analysis, genomics of complex disease and systems biology.

Without a real-world context, large amounts of online trawling and data-crunching can be a turn-off for many students. We have incorporated a mini-research project task to give students the opportunity to experience the sense of discovery, personal contribution and intellectual engagement that can arise through research.

There is little information on the practicalities and outcomes of including authentic research components in bioinformatics courses, although findings from a program at the State University of California that includes a research training internment suggest ~90% of students completing the program ultimately have a career trajectory involving bioinformatics and over half go on to research degrees in the field [1]. We describe the establishment of a research project component in a bioinformatics course and some preliminary outcomes.

2 Method and Results

I. Project Format and Content

Students conduct original bioinformatics analyses of real research data. Due to class sizes (~75 students), students are randomly assigned to groups of 3 per project. Around 25 different mini-projects are provided by research groups of the University of Newcastle's Priority Research Centre for Bioinformatics, Biomarker Discovery and Information Based Medicine (CIBM). Research datasets for the projects include gene expression microarray data from transgenic mice, clinical studies of human disease (e.g. cancers, brain diseases) or RNA interference experiments in human cell lines. Projects address questions researchers lack time to investigate but consider likely to give interesting findings. Students are required to: understand the underlying technology and experimental studies; provide a descriptive analysis of the data; formulate a hypothesis; suggest a predictive model for the problem using bioinformatics approaches; consider the

biological implications and suggest experimental studies that could be used to validate the predictive analysis.

II. Assessment

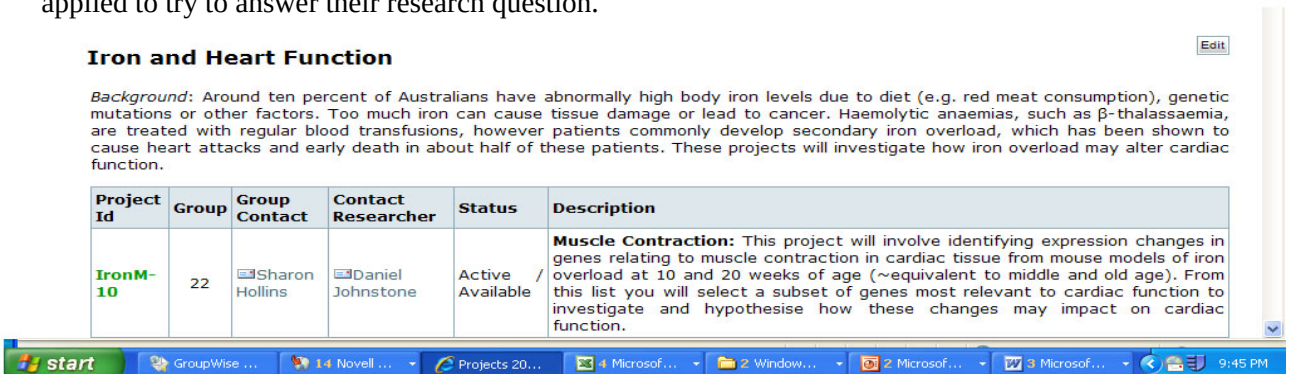
The group is required to give a joint presentation on the proposed project and each student must submit independent, individual mini-research reports including a critical literature review and a description of the bioinformatics methods and approaches used to analyse the data, the results obtained and their interpretation.

III. Administration

Near the beginning of the course, a session is held in which researchers from participating groups speak to the students for around 5 minutes each. This session aims primarily to give the students a sense of the power and wide-ranging relevance and diverse applications of bioinformatics approaches rather than provide detailed information on any particular research areas. Datasets and project descriptions are placed in a permanent online password-protected Wiki registry managed by the CIBM Priority Research Centre. An example along with more information is illustrated in Figure 1.

Figure 1: Example of a mini-project description as it appears on the Research Projects Wiki

The figure below shows an example of a mini-project as it appears on the CIBM Undergraduate Research Projects Wiki page. No limit is placed on the number of projects each research group can submit. Some groups elect to put up a single dataset and associated project, others put up multiple projects associated with a single dataset and others multiple datasets and projects. Datasets can be used for several years running or updated as preferred. Where a group of related projects are posted, the postings are prefaced with a brief general background description followed by the descriptions and details of the individual projects. To minimise the time burden on researchers participating in the initiative all contact with groups is through a single nominated student contact. The role of the researchers is limited to providing pertinent background information (e.g. how the dataset was generated, the particular variables used, the experimental models used) and to providing positive feedback and encouragement. The students are required as one of the main tasks of the project to work out for themselves which of the bioinformatics strategies and tools they have covered in the course can be applied to try to answer their research question.



3 Discussions

The initiative has strengthened the nexus between the University's bioinformatics research groups and undergraduate bioinformatics students. It allows students to become more familiar with local researchers and their work and provides a starting point for keen students to become deeply engaged and active in a research project over a more extended period. This has the potential to benefit both students (e.g. greater depth of skills, professional references, potential for presentation or publication outcomes) and researchers (students acquire more real skills, contribute more to research, more likely continuing on to research higher degrees with the group). While still too early to assess the full effects of the initiative, there has already been an increase in the number of students seeking to do work experience and vacation scholarships in genomics and bioinformatics and it appears likely to increase numbers of students progressing to research higher degrees.

References

[1] Krilowicz, B., *et al.*, Identification of gene regulatory networks by strategic gene disruptions and gene

overexpressions, *CBE Life Sciences Education*, 6: 74-83, 2007.