Using Online Free Access Bioinformatics Tools to Aid Level 3 Genetics Teaching

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Abstract

This project aimed to embrace online free access bioinformatics tools to enhance understanding and practical applications of genetics for level 3 students.

Two groups of students were given the opportunity to use these tools in two different settings; one in a traditional classroom teacher-lead session, the other using pre-recorded online video tutorials.

Students surveyed indicated that online video tutorials are used frequently during revision, but without the guidance of a tutor in person, understanding of concepts is not improved.

INTRODUCTION

Bioinformatics is the combination of biology and computer science. The use of bioinformatics in education and industry has been steadily increasing since the completion of the Human Genome Project in 2003. With the increased availability of new sequencing technologies, large volumes of data are now being produced quicker than we can analyse it. Thus, bioinformatics is an essential discipline to be able to store, manipulate and analyse this data.

Bioinformaticians have traditionally consisted of computer scientists, however there is now a push for biology graduates to upskill in bioinformatics[1]. Additionally, there has been research to suggest that biologists will be out-skilled of the future job market if they do not acquire the necessary bioinformatics skills[2]. The role-out of bioinformatics in biology education however has been quite slow, with most only being introduced at undergraduate degree level. Furthermore, research suggests that in some workforces (such as the NHS), there is a lack of understanding of the bioinformatic discipline[3]

Many bioinformatics programmes are free access online and are run by international consortiums, such as European Bioinformatics Institute (EBI) and National Center for Biotechnology Information (NCBI). Thus, they are available for use by students.

EMBL-EBI NCBI National Center for Biotechnology Information

OBJECTIVES OF THE PROJECT

1. Provide opportunity for learners to practice using programmes under controlled conditions
2. Gain student opinion on the integration of bioinformatics into genetics lessons
3. Disseminate tutorials to science staff and offer training

PROJECT APPROACH

Initially, expressions of interest was sought from Level 3 science groups to ensure that the project would gain a high number of participants (at least 10 per study group). It was fortunate that science students across all groups had recently completed their genetics modules, thus the relevant background information was fresh in their minds.

Two separate study groups were designed (*Table 1*). Initially, ten interested learners were invited to in-person 1-hour workshop on how to use bioinformatics programmes. Learners were picked from a variety of groups, ages and genders for standardization.

All other interested students were provided a link to online YouTube tutorials (*figure 1*) and instructed to follow these at their own pace

SCAN ME

Figure 1: QR code for YouTube bioinformatics tutorial playlist

Table 1: Overview of study design

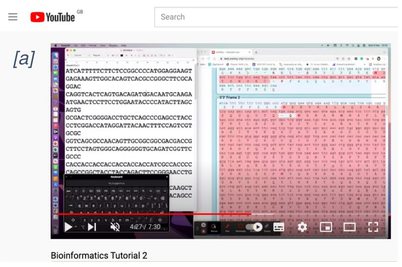
In-person Group	Online Group
• Tutor-led instruction • Tutor set pace • Tutor observation of practice	• Tutor-led online instruction • Learner set pace • No opportunity for observation

All learners were given instructions on how to complete the following tasks:

- Searching for a DNA sequence using the NCBI database[4]
- Translating a DNA sequence into amino acids using SIB Expasy Translate[5] *(figure 2 a)*
- Comparing sequences using NCBI Blast[6] and EBI ClustalO[7]
- Searching for protein structures using Uniprot[8] *(figure 2 b)*

Following the workshop, learners were invited to complete an online survey using Jisc about their experiences. The online study group were also invited to complete this survey.

[a]



[b]

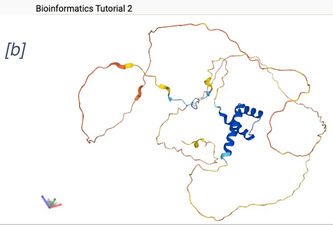


Figure 2.
[a] Screenshot of online tutorial on using Expasy Translate, showing accessibility of keyboard commands and expected results.

[b] Example protein structure (HOXA1) obtained using Uniprot

OUTCOMES FROM THE PROJECT

Of the ten students invited to the in-person workshops, nine attended and completed the survey *(figure 3).* 11 individuals completed the survey indicated that they completed the online tutorials, but this does not correspond to the number of views of the four online tutorials (17, 9, 8 and 5 views respectively for tutorials 1-4).

Of the 20 people surveyed, 26% of individuals said they use YouTube videos regularly to aid their learning. Other online sources (such as educational websites) also ranked highly (*figure 4).* Additionally, 86% of those surveyed ranked their prior knowledge of genetics as moderate to excellent. However, only one individual surveyed had heard of bioinformatics as a discipline prior to the project.

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Figure 3: QR code for Jisc Learner Survey

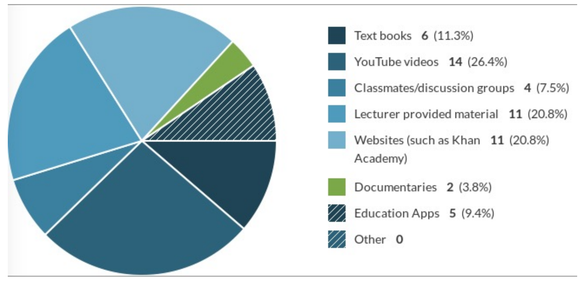

Figure 4: Survey results for student preferences when learning new concepts

Whilst 100% of online participants found the videos at minimum moderately easy to following, only 72% said they understood the processes they were completing, showing the the online tutorials themselves were not enough to understand the complexities of the processes.

In comparison, 90% of in-person participants found the workshops useful, 80% found the sites easy to navigate, and 90% said they understood the processes they were completing.

Following the activity 63% of participants said they would use online videos in the future to aid their learning. However, when comparing the improvement in understanding of genetics concepts following the activity, the in-person cohort scored higher than the online cohort (*figure 5*).

[a] [b]

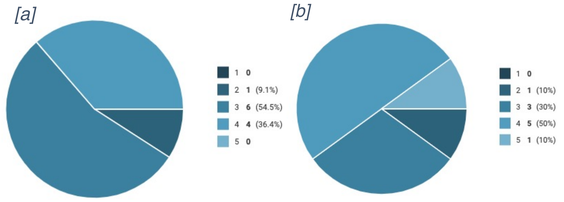

Figure 5: Survey results for improvement in understanding (self assessed) following activity for those who completed the online tutorials [a] and the in-person tutorials [b]

CONCLUSIONS

The survey results show that, whilst online pre-recorded workshops and tutorials can be a useful aid, they are not sufficient in replacing either in-person, or live online lessons. This should be an important consideration in curriculum design for our post-COVID world.

During the in-person workshops, many students asked questions, and required additional guidance. At times, some learners required reassurance that what they were doing was correct, feedback that the online group lacked.

Looking at the online video views, it is also apparent that not all students completed all tutorials. Further research is required to ascertain why as none left comments as an indicator. From face-to-face conversations with some members of this cohort after however, some cited workload, whilst other said they lost interest without external encouragement.

FUTURE ACTIONS

From discussions with students, further development of online tutorials is required, particularly in improving the video design.

Most students that completed the in-person workshops stated that they enjoyed the sessions and would happily attend more as an extra-curricular activity. Thus, there is scope to improve and expand these tutorials, possibly as part of their study skills or stretch and challenge sessions.

Once activities have been modified and improved, lesson plans can be drawn up and disseminated to science staff, with CPD being offered to pass on these skills to teaching peers. These would be useful mainly to those who teach either biology or biochemistry.

There are further online programmes to aid in teaching chemistry and concepts that can also be explored.

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