Using clickers to enhance interactive learning in Biochemistry 364

Faculty of Science | Department of Biochemistry

Module: Biochemistry 364
Lecturer: Prof Johann Rohwer jr@sun.ac.za
Blended Learning Coordinator: Dr Ilse Rootman-Le Grange ilser@sun.ac.za

Learning activity:
Formative assessment

Learning technology:
SUNLearn clickers

Context

Background overview

The Biochemistry 364 module consists of 3 sections covering "Protein structure and function" and covers general advanced material found in several sources (text book, scientific literature, and internet). It consists of a mix of factual and conceptual learning. This being a third-year module, the material is relatively advanced and has a fair amount of depth. Despite this, assessments had previously focussed in part on mere regurgitation of factual knowledge. Also, the lecturer found it challenging to motivate the students to engage with the material in such a way that they would move beyond this rote learning mode.

The impetus for this study was provided in particular by three worrisome developments over recent years: first, levels of class attendance were very low (averaging at ~40% of registered students); second, class sizes are huge (170 for a 3rd-year module); and third, when students attended classes, they were mainly in "receptive" mode, with little participation. As a consequence, many students experienced problems when presented with assessments that moved beyond regurgitation of facts.

Established practice

The module has previously been taught in a classical classroom approach. Content was "delivered" in three lectures per week, and students subsequently had to apply this knowledge during a 3-hour tutorial by solving problem sets. To counteract the developments listed above, various interventions were introduced. These differed between the sections of the module that consisted more of factual learning, and the section on enzyme mechanisms that was heavy on conceptual knowledge.

Learning and assessment activities

Learning activities

The main interventions were the following:

- formative assessment during lectures using cellphone-based clicker technology via the SUNLearn platform;
- the use of specialised subject-specific software during tutorials and summative assessments (assignments);
- the use of open-book summative assessments in class tests.

For each lecture, a set of multiple-choice clicker questions were designed. These questions were interspersed throughout the lecture and would test the application of a particular concept that had just been discussed in the class. The students would then be given one or two minutes to answer the questions (either alone or in pairs) and the instructor would have immediate access to the results, allowing him to adapt lectures on the fly to remedy weaknesses and fill in gaps. As a consequence, students were already "forced" during the lecture to move beyond mere rote learning of facts. It also provided a convenient break in the lecture and slowed down the pace.

The concepts were then further enforced during tutorials and assignments by using specialised subject-specific software (PyMOL, freely available for educational use) for visualising protein structures in 3D. This allowed the students to "play" and explore the material on their own and translate the dry theory from the lectures into a visual practical experience. The formal written assessments (class tests) were open book, which by default precluded rote learning and required that the questions be designed in such a way as to test insight and application of concepts rather than reciting facts.

Student experience

Student feedback on learning experience

The implementation of the clicker approach led to a dramatic increase in student participation during the class, as students were given a safe space to answer questions without fear of being exposed in front of their peers. This is especially pertinent in such a large class size, where it can be extremely challenging to get an interactive discussion going.

There was also a significant improvement in class attendance; however, this had to be incentivised. Since the clicker also affords the opportunity to take a roll call, students were offered a 5% bonus mark for the section if they attended at least 9 of the 12 lectures and participated actively in the clicker. This proved essential, as the same approach was previously attempted in a different module without the incentive: this had no impact whatsoever on the class attendance, and moreover the participation in the

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clicker activity was mediocre (40% of the students present on a good day). With the incentive, however, virtually everyone present also participated in the clicker, and out of a class of 173 students, 101 qualified for the bonus. Such a compulsory system should, however, be implemented with the caveat that alternatives are given to students who cannot participate in the clicker for whatever reason (e.g. because they have no suitable device to participate, or do not want to use their own mobile data for academic purposes). In our case, students were given the opportunity to sign an attendance register after each lecture in order to accrue participation credits towards the attendance bonus.

The data from the clicker also allowed us to correlate attendance and participation to achievement in assessments. Figure 1 shows this relationship for the written class test, which was an open-book assessment comprising a combination of multiple choice and longer questions. The data showed a positive correlation (R = 0.462) of achievement with increased attendance.

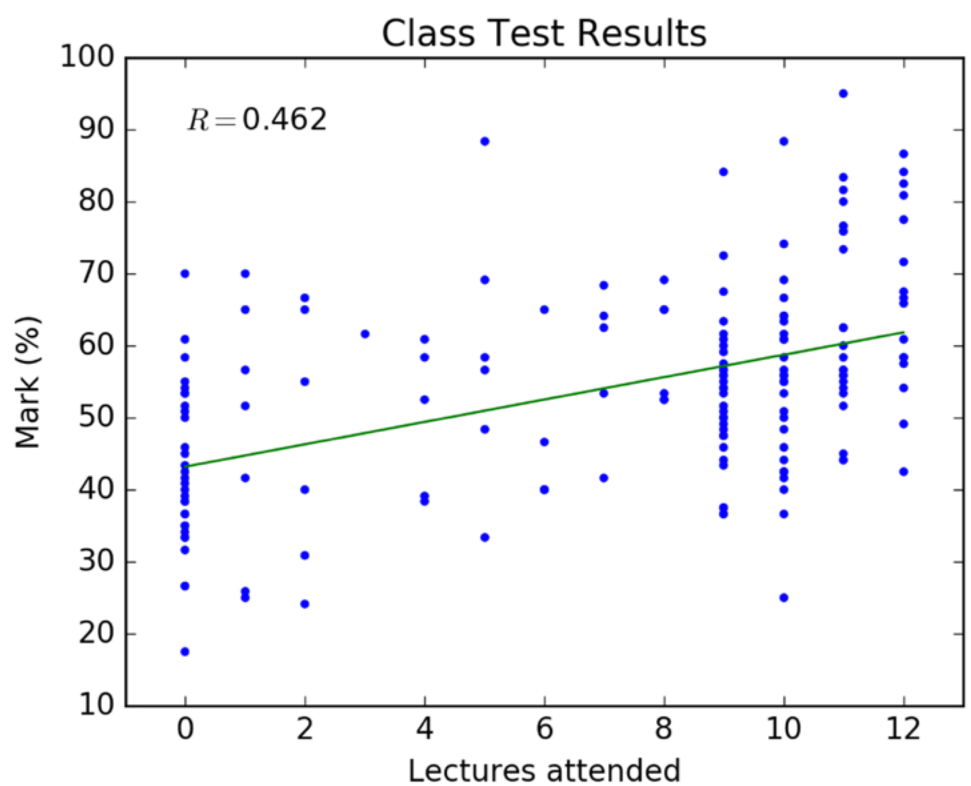

Figure 1: Correlation between attendance and participation to achievement

The feedback from students was immensely positive. Some quotes on the best aspects of the module Biochemistry 364 praise the module as "interactive" and state that the clickers assisted the students in understanding the concepts.

There was only one remark concerning the clicker in the aspects that need improvement, but it did not elaborate. It only stated that the clicker was the problem and "#Clickermustfall".

Concerning aspects of the lecturer's teaching that should be maintained, a total of 15 out of 34 comments mentioned the clicker directly, and an additional number indirectly. Some examples:

- "Ons het baie voorbeelde ontvang om ons te help om die werk in te oefen." [We received many examples to help us practice the work.]
- "Clicker questions after concepts keeps us focussed."
- "The clicker questions helped you to stay concentrated in class and the enthusiasm of the lecturer was admiring."
- "Good at explaining. Provides examples + work questions for students, to practice and apply what they're learnt."

Finally, the same section was presented in 2014 with a traditional approach and in 2015 as outlined here, allowing for a direct comparison. The student feedback score on the lecturer (average of 11 categories) increased by 0.13 points (out of 5) in 2015.

General

Other concluding thoughts

The main advantages of the approach outlined here are that it facilitates interactive learning and participation, especially in large classes; that it allows the instructor to ascertain in real time by means of formative assessments whether students have grasped difficult concepts and to adapt the lecture on-the-fly if necessary; and that it incentivises student class attendance.

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Good network infrastructure is absolutely imperative for implementing this approach successfully. It should only be attempted in lecture theatres that have been equipped with Wi-Fi access points. When students struggle to connect or submit their answers, this will only cause frustration and undo the benefits of the interactive learning.

Designing effective clicker questions involves a lot of thinking and hard work, because these questions should firstly test whether students have grasped the concept, but ideally also offer answer options that encompass common misconceptions. Fortunately, the questions can be recycled in subsequent years; in this case the clicker questions were never handed out to the students (despite repeated requests to do so).

Finally, the clicker data from SUNLearn can be downloaded in an Excel spreadsheet; however, it is cumbersome to extract participation data from this spreadsheet by hand. For this purpose, a custom Python program was written that will extract these data automatically. Instructors who are interested in adopting this approach can obtain a copy of this program from the author.