WHAT IS 'STUDENT-CENTRED LEARNING' AND WHY SHOULD WE CARE?

Liz Johnson*
Department of Biochemistry, La Trobe University, Bundoora, VIC 3086
*Corresponding author: e.johnson@latrobe.edu.au

Student-centred learning is a phrase used to describe an attitude to teaching and learning that has the student as the primary focus. This sounds obvious until we think about what we teach and how the material for the curriculum is selected. Is your curriculum described by selected topics from your favourite texts? If that is all that the curriculum includes, it says very little about what the student can achieve in the classes. Student-centred learning requires us to understand what is happening in the classroom from the student point of view and takes into account the experience and objectives of the students. The results for a student-centred course are learning outcomes that are of lasting value to all students. What will the student use or even remember five years after that final exam?

Catering for Diversity in the Class

Of course, the learning outcomes for any individual student depend a great deal on the characteristics of that student. Research into the characteristics of learning in higher education show that the past experience of the student in learning and external factors (part-time work, home environment) are major determinants of the effectiveness of learning (1). Many factors are highly personal and vary greatly between students. A teacher planning curriculum and learning activities needs to take into account the diversity in the group. Students vary in their motivation for enrolment and in what they hope to achieve by completing the course. Are they fascinated by biochemistry, just curious or required to complete the subject by the conditions of their degree? Understanding student objectives and motivations helps to tailor the course to the group. Even simple strategies, such as illustrating biochemical pathways with practical examples from other subject areas from the student's course, may improve the motivation to study. A good match between student objectives and the curriculum has been shown to promote more intensive and productive learning (2).

It is useful to find out, preferably from the students themselves, what they are interested in and what they hope to achieve. This can be achieved even in large classes quite simply by using in-class surveys (e.g. write down three things you could learn in Biochemistry that will help your study in other subjects) or with focus groups. It is not sufficient to base curriculum on the undergraduate experience of the academic staff teaching into the course. Academic staff were, almost by definition, excellent students in traditional courses and our motives are unlikely to be shared with all of our students. Recent studies describe what motivates students in Australian universities and some of the findings are somewhat surprising. Both undergraduate students and senior high school students in New South Wales reported that the major aspects relevant for choosing a career in studying science, technology and engineering were the benefit to the community and the opportunity for variety and challenge (3). The perceived relevance of the material taught appears to be a major factor in student engagement.

Students also have different learning styles or strategies. A learning style describes the preferred way a student acquires and uses information. Some students work best in collaborative projects, while others get further researching on their own. Some students want their teachers to organise their learning, while others prefer their teachers to be mentors or experts for consultation. Felder and Brent (4) argue that the best instruction includes a range of teaching modes, each of which can appeal to different learning styles. This allows students to learn in the way that most suits them, but also requires them to work with types of tasks that they may encounter later in their career. The class is not tailored to an individual student, but caters for a wide range of students. Given the increase in large undergraduate classes in Australian universities and the falling staff to student ratio (5), our classes will inevitably be more and more diverse. Our curriculum should take this into account by including a variety of learning tasks targeting different learning styles and outcomes.

A third area of diversity in the classroom is in the student's approach to learning. Early studies of learning described the pursuit of a thorough understanding of a topic as a deep approach to learning, while rote learning or 'plug and chug' problem solving was described as a surface approach (6). A number of authors have applied this idea to higher education and developed the idea that students can be led to a deep approach by appropriate curriculum (7). A large proportion of students have a strategic approach, using deep or surface approaches depending on what is required by the assessment task. Legget *et al.* (8) found that undergraduate students rated the acquisition of specific skills as important when assessment obviously depended on those skills. If we want our students to engage with our discipline, we must ensure that assessment tasks require them to do more than write out the material provided in lectures. Examinations that can be answered by reproducing material from texts or notes point our students towards a superficial view of biochemistry, no matter how interesting the lectures have been. An effective curriculum has assessment that matches the objectives and learning activities used during classes.

As teachers, we need to recognise that all the students in our classes should be able to achieve something worthwhile from the experience. Even students who do not continue with our subject should be able to see connections with the rest of their study or practice useful skills.

Generic Skills and Attributes

The recommended curriculum for an undergraduate major in Biochemistry and Molecular Biology published by the American Society for Biochemistry and Molecular Biology lists both content to be covered and skills that students should acquire (9). Students are expected to develop discipline-specific skills such as laboratory and experimental techniques, but also those less tangible attributes such as "ability to collaborate with other researchers" and an "ability to think in an integrated manner and look at problems from different perspectives." Skills sets such as these are a good match to the graduate attributes that appear in the learning objectives of courses in many Australian universities (10) and reappear in the studies of what employers seek in graduates (11). The pressing question is how these skills can be developed in the classroom. How can we ensure our students do more than learn facts?

The answer lies in setting tasks that require more. In my second year Biochemistry class, we have a set of practical sessions on enzyme kinetics. The original experiment was to measure the K_m and V_{max} for alcohol dehydrogenase, which is a robust exercise even for inexperienced students. However, following a prescribed recipe limits the students to following my train of thought and makes them passive recipients rather than active learners. We rewrote this experiment by asking the students to explore a parameter of the experiment for themselves. After an initial practice experiment, they design and perform an experiment that explains the effect of their chosen parameter (pH, temperature, substrate, inhibitor) on the reaction. Since there is no recipe for this, the students must decide what controls to use, what a null result means and whether or not their data are meaningful. There are many published examples of this learning strategy captured in journals such as *Biochemistry and Molecular Biology Education (BaMBEd)*, *Journal of Chemical Education* and *Cell Biology Education*. Recent examples in *BaMBEd* include Howitt (12), Black, Tuan and Jonasson (13), and Briese and Jakubowski (14).

Teaching journals are also excellent sources of materials designed to develop other skills, such as finding and interpreting information, communication and applying information in a new situation. A range of teaching pedagogies has been developed to expand the student capacity to explore and learn (15). Case studies and problem-based learning exercises encourage the development of independent research and problem-solving skills and are often used to develop collaborative skills. Peer-learning tasks require students to take on the role of teacher and make themselves expert in an area, contributing to a group understanding. All these approaches are designed to push the students beyond a superficial understanding of the subject matter to interpretation and application of their knowledge and even to an understanding of how they learn and think. These skills are much closer to the characteristics of successful researchers (16,17) and to the desired graduate attributes of the tertiary sector.

Scientific Literacy in the Community

The majority of students in my Introductory Biochemistry class will not become professional researchers, either in my field or elsewhere. Why should I tailor my teaching to suit them? This question was posed at an Education Workshop at the recent IUBMB meeting in Athens. Apart from that we are paid to teach these students, I want all my students in my class to understand a scientific approach to problems and issues. I want them to be able to make informed decisions about controversies over stem cell research or genetic engineering. I want them to be able to understand why claims for instant weight loss treatments should be treated with scepticism. Above all, I want them to understand the value of science and scientific research.

This means I need to include teaching exercises in my course that ask the students to develop these capacities. They could independently gather information, evaluate it and work out for themselves how scientific knowledge is advanced. They could debate the accuracy of reporting of scientific issues in the media or could work together to discuss and teach each other scientific principles. And above all, I need to give these exercises real weighting in their assessment, so the students believe that it is important.

Student-centred learning is a philosophy of teaching. It is not a didactic teaching method, as there is no 'right' way to work with students. Teaching should be adapted to suit the characteristics of the student group, the skills of the teaching staff and the objectives of the course. Student-centred learning asks us to keep the outcomes for the students paramount and to make those outcomes of maximum value to all students in the class. I want all my students to be engaged with my discipline and with science generally because it is relevant to them. I need them to achieve something they consider worthwhile from my classes and I must remember to put myself in their shoes regularly.

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