Letter to the Editor

Teaching Biochemical Pathways Using Concept Maps

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Dear Editor

The interesting paper by Dinarvand and Vaisi-Raygan (1) makes valuable points about a particularly challenging aspect of biochemistry learning and teaching. Their work prompts me to ask two questions and make a comment.

First, what do the authors mean by a concept map (CM)? A pathway map could be considered a CM, but a CM could cover modes of regulation and kinetics in relation to particular reactions or pathways and there are many other possibilities. Irrespective of this, a CM can get extremely complex if more than a few concepts are involved (2), as can be seen in examples given by Novak (3). This is the fundamental problem of teaching and learning biochemistry (4), which combines the network of pathways, compartmentation, macromolecular structure, regulation, kinetics and some fairly sophisticated chemical concepts.

Second, how did the students go about preparing CMs? My experience is that students prefer to use a computer for most tasks, but standard CM software (5) may not be suitable. For example, they often struggle unnecessarily to use software to prepare a graphical summary of the structural features of a protein, its precursors and the gene encoding it. This distracts them from the material. My suggestions that pencil and paper might be sufficient are usually met with amazement.

Third, as Dinarvand and Vaisi-Raygan (1) make clear, a coherent summary of the metabolism considered in a course in metabolic biochemistry is crucial if students are to appreciate the pathways and their interconnection and regulation. For many years I have used an approach in which students collaborate in tutorials to achieve this. The sessions are usually initiated by me drawing the plasma membrane and the mitochondrial membranes on a large board and inviting the students to fill in the blanks (I provide large sheets of paper so that students can make copies). With coaxing, someone volunteers and I explain that the volunteer is not alone because everyone is expected to help and, eventually, everyone will be the volunteer. Thereafter, I act as moderator, provide support to any nervous students and, very rarely, offer some clarification, correction or suggestion. The sessions are very lively and highly productive. We usually spend one week going over the details of the reactions in all the pathways we have considered, and in the next tutorial we generate a simpler outline of the reactions and superimpose the regulation of the pathways.

In addition to the generation of a coherent overview of the pathways and processes, the advantages of this approach include instant feedback on the suggestions made by students (often provided by other students); real discussion of the biochemistry; identification of particular points of difficulty; the voluntary inclusion of almost every student, which gives me some indication of those who might be struggling; and laughter. The feedback is consistently positive and students actually ask when the sessions are going to happen as we approach the end of semester. A similar approach works just as well when summarizing a semester's work on cell and molecular biology.

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Authors replay

We would like to thank Brown (1) for considering the study conducted by Dinarvand & Veisi Raygani (2). In reply to his questions, we would like to argue that the students participating in this study were told about what the concept map was and what applications it could have in the teaching-learning process. In this study, having attended the class, the students referred to authentic biochemistry resources and creatively drew simple concept maps using paper and pen and taking into account the pathway maps drawn in the given resources. In task-based teaching methods, the student, as the main factor in the learning process, is encouraged to do the task (3). To draw the concept map as a task, in addition to attention to classroom materials (4), the student should critically view the metabolic pathways drawn in the biochemistry resources to innovatively establish an organic relationship between materials. In this study, the objective was to concentrate on learning metabolic cycles of carbohydrates by drawing student-made concept map as homework assignment. The applicability of this method for other subjects of biochemistry and generally biosciences requires more research.

The authors believe that the strength of this study was the motivation of the pharmaceutical students in the learning process which encouraged them to draw completely self-made creative concept maps at home in order to learn the materials more efficiently. The authors would like to confess that the student-made concept maps were simple and some of them had technical problems. However, we did not intend to create complicated and technical concept maps, but our main objective was to use concept map to learn the classroom materials more effectively. To make concept map more helpful in education, students should be encouraged to draw concept maps, even though basic and simple, using their thinking and creativity to better digest the difficult subjects of metabolism. Thus, there was no need to mentally involve the students in computer software. Of course, more comprehensive software for drawing concept maps should be designed by other researchers, as well.

We would like to thank Brown again for his worthwhile questions and comments. We should point out, however, that this study is not free of deficiency due to administrative constraints, but this study is the start of a process not the end of a research proposal; the start of a process to develop creative teaching-learning methods to teach the difficult subjects of biochemistry course more efficiently.

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