Concept Maps:

Finding Our Way on the Road to a Standards-Based Classroom

As in all journeys, the road to meeting educational standards begins with a single step. In this case, that step is a new instructional technique.

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Okay. We admit it. For years we conducted our biology classes in a traditional didactic format. After performing our song-and-dance routines (which we thought were thoroughly engaging), we would be disheartened when our students either failed to learn the material or didn't retain it. We would lament to one another, "We're pouring our hearts out, and they're just sitting back and letting us do all of the work!"

The National Science Education Standards (NSES, National Research Council, 1996) stress that students need to take responsibility for their own learning. One way of doing this is to provide students opportunities to show their understanding of scientific concepts as the concepts relate to other aspects of their lives. Working together in small groups and sharing ideas enable students to explain, clarify, and justify what they have learned. The Standards state that students should be offered opportunities to express their ideas using traditional and nontraditional means (i.e., pictorially, graphically, and orally). Students come from different cultural backgrounds and have varied learning styles. The NSES recognize that teaching methods should address these variations.

Beginning Our Journey

With all this in mind, we decided to try some new techniques to address one of the most significant problems in our classrooms: our students were not making the needed connections with the big ideas in our curriculum. According to David Ausubel's (1968) learning theories, students need to connect their new ideas with concepts that they already know and understand. Joseph Novak (1998) suggests that graphic organizers, such as concept maps, are a way for students to visually represent their ideas and show these conceptual connections.

Thus, we chose to begin our journey into the age of educational reform with concept mapping. We introduced the technique with a collaborative activity in which each group produced a concept map. Since the students had already spent time in class covering the characteristics of living things, we chose this as the topic they represented on their practice maps.
Each group was given a packet of sticky notes, an overhead transparency, and a marker. We told them to list concepts about the characteristics of living things on the notes and to try out various arrangements of the notes on their tables. When they found an arrangement that best represented their understanding of the relationships between the concepts, they were to transfer the terms onto the group's overhead and to write linking terms on the connecting lines.

According to Novak (1998), the terms linking concepts together on the maps are essential to the maps' effectiveness. These terms show the relationships between the concepts and provide the conceptual glue that binds the ideas together. Without the linking terms, the concepts are just a set of vocabulary terms that are arranged on paper. Even though the students were familiar with the introductory activity's topic, and we emphasized the importance of the linking words, the students struggled with the concept. This should have been an indication of the troubles that were ahead.

**The Test Drive**

Our next step was to ask students to construct maps on the topic of photosynthesis. Figures 1, 2, and 3 show examples of what the students produced. These three maps illustrate that the students were at different levels in terms of their understanding of the concepts as well as their proficiency at using the tool.

The concept map in Figure 1 was constructed collaboratively by three students. The map shows that, while they had some grasp of photosynthesis, there were misconceptions and holes in their understanding. For example, they clearly knew the parts of the chloroplast, but their idea that "water and sunlight makes photosynthesis" showed that they had not achieved meaningful learning. We noticed that these students seemed more intent on having a "product" than in constructing a map that helped them understand the concepts.

![Figure 1. Concept map showing students' misconceptions.](image)

Figure 2 shows a map constructed by an individual student. This map demonstrates that she could logically arrange the terms associated with photosynthesis. However, without linking terms, her graphic communication was incomplete. It was unclear whether she had deeper understanding than the first three students. The linking terms she did use indicated her difficulty in determining appropriate relationships between the concepts. If she had added linking words, perhaps she would have solidified her learning.
Figure 2. Without linking terms, the concept map is incomplete.

The use of linking words by the student who completed the map shown in Figure 3 gave us a more complete view of her understanding of photosynthesis. Although her understanding was not entirely accurate, her linking words showed us the areas where she needed help. The complexity and web arrangement indicate that she was integrating the information on several levels.

Figure 3. Although the content of this map is not entirely accurate, its complexity reflects the depth of the student's understanding.
In all three cases, the mapping gave students an opportunity to concretely represent their understanding. It allowed them to reflect on what they knew and to take some responsibility for their own learning.

One of the most beneficial parts of the mapping process was the way the products focused the students’ class discussions. These discussions began with the students standing in front of the class and explaining the reasoning behind their constructions. As they spoke, they often caught their own mistakes. Classmates asked questions that further drew attention to problem sections of the map. As in any discussion, being exposed to others' perspectives helped clarify and enrich the participants' ideas.

In addition, both the concept maps themselves and the students' presentations and discussions were extremely valuable as formative assessment devices. Careful analysis of students' understandings helped us shape our instruction to meet their needs.

**Potholes in the Road**

Since the experience was our first time test-driving the concept mapping process, we ran into several potholes. The first pothole we faced was that the students needed to have more prolonged exposure to the technique before
they became proficient. They often spent too much energy trying to figure out how to organize the maps and not enough time analyzing the content behind them.

Perhaps because of the time factor, many students never stretched themselves to find the appropriate connecting terms. Because they didn't take advantage of the full power of the tool, some students felt that the mapping exercises were a waste of time or busy work.

Another problem was finding enough class time to fully discuss the student-generated maps and to allow groups to work together. It is often hard for teachers to give up class time to try out a new method. They are often concerned that the required content will not be covered even if the new technique has the promise of helping the students learn the material.

Perhaps the deepest pothole of all was students' resistance to taking responsibility for their own thinking and learning. Most of the students had become comfortable in their role as vessels to be filled with information by their teachers, and it was difficult for them to readjust their approach.

Patching the Potholes

Even though we had these problems, we both feel that student-centered approaches in general and concept mapping specifically can be educationally powerful. So how are we going to patch the potholes in our facilitation of our students' learning experiences?

One patch would be to give students more instruction in creating concept maps. We believe that it is important for teachers to repeatedly model the technique, but they need to be careful not to map concepts students will analyze later, on their own. The danger is that students will parrot the material back with little understanding. However, we suggest using maps occasionally to present small parts of material being studied. Teachers can also facilitate group mapping exercises by helping out when students are stuck in one of the potholes. These activities should decrease as students become more proficient.

The students also need opportunities to reflect on their understanding of the course content through the use of less complex graphic organizers and then move on to small concept maps that concentrate on a specific topic. For example, instead of designing a concept map about photosynthesis, students could develop small maps for topics such as chloroplasts, light reactions, and dark reactions that allow them to break the process into manageable chunks.

Students need help to learn to connect interrelated concepts and to think about the mapping process in a metacognitive way. As they slowly acquire those skills, their concept mapping will be more effective and more valuable. Scheduling classroom time for these opportunities is important to the technique's success.

Sometimes you need a gimmick to capture interest. In the computer age, some students may be turned off by looking at handwritten papers or transparencies done
by others or even by themselves. Use of Inspiration software is one way to generate concept maps that may appeal to the technical side of many students.

Finally, once the NSES become the norm in our schools, students will be more comfortable with taking responsibility for their own learning. If their whole educational experience has been student centered, then it won't be such a shock when they are in a class with expectations for high levels of involvement.

Next Steps

Not all educators agree about the best ways to use concept maps. For example, Novak (1998) suggests that they can be used as a learning tool and a way to communicate understanding to the teacher. Barnekow (1998), on the other hand, states that even though graphic organizers are excellent communication tools, they should be used only as a way for the students to learn, not as a way for the students to communicate what they have learned to the teacher. As is the case with any teaching and learning method, it is important to customize the use of the tools in any way that improves meaningful learning for the students.

Would we try to use concept maps in the future to help our students learn? Yes. Although our students and we struggled, we have confidence that everyone would feel more comfortable and proficient with more practice. Our past experience has proven that didactic methods are insufficient and that teachers need to give students more responsibility as well as opportunities to reflect on their own learning. Concept maps can help achieve both of those goals.

The information for this article was gathered while the authors were teaching a class at Columbus State Community College.

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References


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**Citation information**