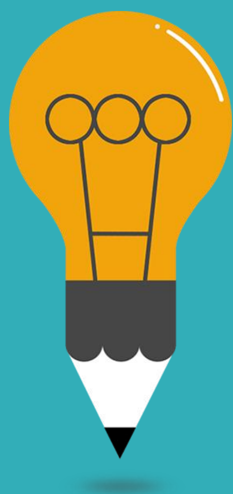

UNLV GRADUATE COLLEGE

Representations in the science laboratory

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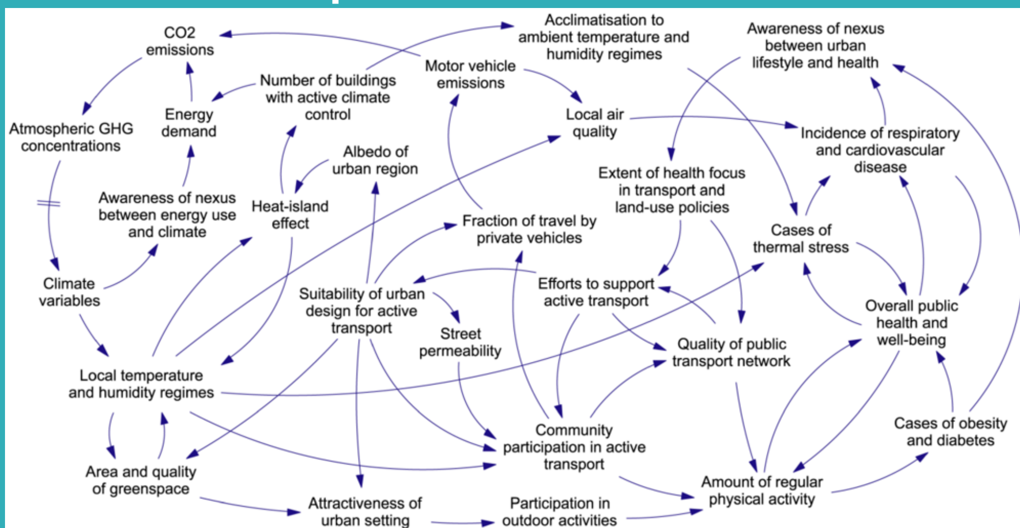
1

A quick introduction….



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2

The following scientific diagram from a science discipline (not chemistry) was shown as the opening ice-breaker activity. Attendees were asked to answer the following questions: (1) what is the important information that this diagram is trying to get across, (2) what should you as the viewer take away from the image and what are some of the important details, and (3) where should you focus your attention in the image? The audience members were encouraged to discuss their thoughts with other participants. These directions took about 60 seconds to deliver, and then the image was removed from the screen with the explanation that we usually provide our own students about that much time to understand new information from a slide. After briefly discussing the content with others, the presenter placed the slide back on the screen. The participants were then asked (1) what are some things that would have been useful to interpret this image, and (2) what would you have liked to have explained to you to understand this information? This activity was used as a way to allow the seasoned instructors to remember the anxiety sometimes experienced when learning complex new material from diagrams that they do not yet possess experience with.

Outcomes

What can I take away from this presentation?

01 **Learn about representations**
What are representations?

02 **Learn why they are important in science**
How do students use science representations?

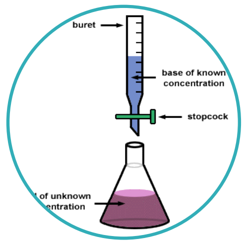
03 **Learn some best practices for using representations**
How can my students benefit most from a figure?

04 **Discuss some of your representations**
Get some feedback on your own figures.

3

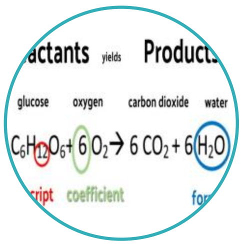
The outcomes for the workshop were presented to the participants. By developing the workshop and making it available to any graduate students, post-docs, instructors and faculty we intended for a broad audience inside and outside of chemistry to learn about representations, how they are used and how they can be challenging to learn from, and what we can do as instructors to make learning from them more productive for our students.

Representations



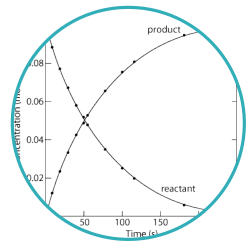
Pictures

http://www.sparknotes.com/chemistry/acidsbases/titrations/section1/



Symbols

http://onlinesciencenotes.com/chemical-reactions-balanced-and-unbalanced-chemical-equations/



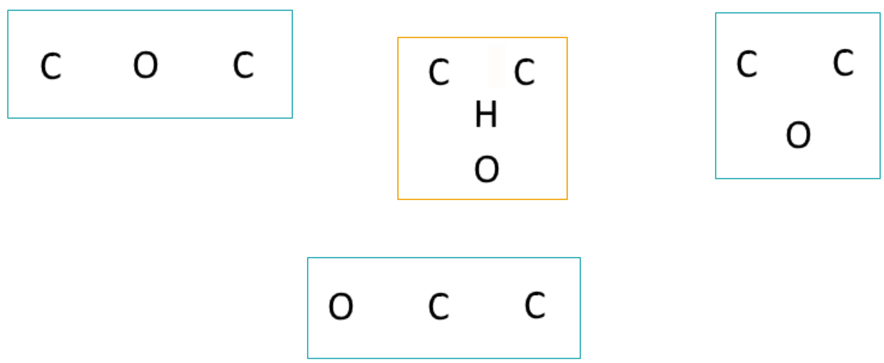
Graphs

http://www.algebralab.org/practice/practice.aspx?file=Reading_ReactionRate.xml

4

After introducing the presenter, her qualifications, and her reasons for hosting the workshop, the participants were introduced to different types of representations typically used in science and chemistry classrooms. These were noted as the graphs, charts, images, pictures and symbols that we use to describe the science concepts that we teach in a visual fashion. It was explained that these visuals allow the learner to make connections between their own knowledge and the new information, and that experts use these images to explain concepts to one another. Also, science, and chemistry in particular deal with the study of abstracted ideas and therefore we require images and symbols to be able to explain, understand and visualize what's happening.

Interpreting Representations



5

Then the participants were asked to recall learning about Lewis structures for the first time. Lewis structures are a useful example of how students can sometimes struggle with representations because they do not yet have enough experience with them to understand what they mean, how they can be used, and when they are correct. These abilities typically come from learning and understanding conventions and "common sense".

Why do Students Struggle?

- Figures aren't transparent
  - Students cannot interpret the implicit meanings
- Students with lower prior knowledge cannot recognize which information within the representation is most important
- Students cannot relate certain parts of the representation to other parts

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A list of concrete and research driven reasons for why students are challenged by features of representations used in learning chemistry was given and each item explained. These include students' inability to interpret the meaning behind a representations, their inability to recognize what is important and what is not when they have low prior knowledge, and their inability to relate features of representations to each other to make meaning.

Representational Competence

- The ability to interpret a representation in order to gain understanding of the underlying concepts

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The idea of representational competence, or the ability to interpret and use representations was put forth as a final goal for our students learning complex material through representations. In order to achieve this goal, a two part approach was recommended: teaching our students explicitly about visual literacy, or how to interpret and understand the images that we present in real time, and minimizing the visualization difficulties within the images that we are currently using.

Representations Best Practices

1) Be aware of how students learn and visualize
    a. The most gains come from active learning (group work, etc.)

2) Consider your students' ability to reason through a representation
    a. What concepts should the student have mastered in order to understand the image?

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A list of best practices derived from Schönborn and Anderson (2006) specifying guidelines for biochemistry students was condensed to help participants when selecting or critiquing their own images. These included promoting active learning for students in the classroom when presented with representations. This can take the form of group discussion and sharing of thoughts among peers. It also included considering what knowledge the student should possess when confronted with a representation. In other words, the image selected should be appropriate to the knowledge level of the viewer and not contain lots of information that they cannot yet parse.

Representations Best Practices

3) Make the content encoded by the representation explicit
    a. Point out what the image represents and also what it does not

4) Explain any visual language or conventions shown

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The next suggestion was to make any content encoded by the representation explicit. It can also be helpful to point out what an image represents and what it does not. Some images are better at providing certain details about a concept than others and this should be made clear. Another suggestion was for the participants to explain any visual language or conventions shown in their images. That includes anything that is required to understand what the image represents. An example would be the type of arrow used in a chemical reaction. It can't be assumed that a student knows what it means the first time they are encountering that information.

Representations Best Practices

5) Use multiple representations where possible to complement and contrast
    a. Point out the limitations of each

6) Have students generate their own representations

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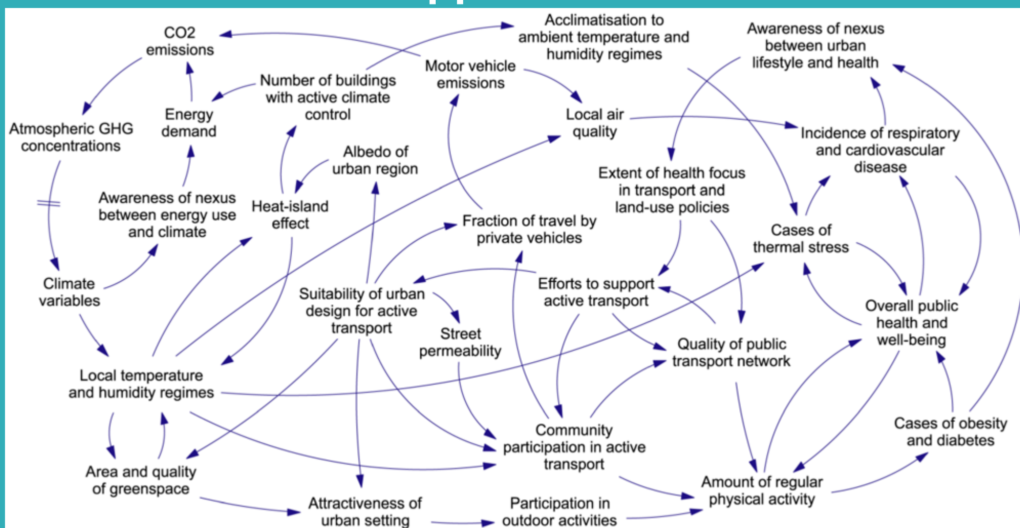
Another suggestion was to use different representations when possible to convey information about the same topic. Since some images have constraints, it was recommended to use several to present information from a different perspective. Also helpful to students is when the reasons for why one diagram is more useful at conveying certain information about a topic than another are made explicit. Finally, literature supports the idea that students should generate their own representations in order to become more fluent in their use. Experts spontaneously use self-generated representations to explain science concepts to each other and having students do the same is a good method of practice. This can encourage students to consider the details within the representation, and therefore pushes them to understand the underlying concepts more thoroughly.

Application



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11

The complex scientific diagram from the beginning of the workshop was shown once more, and participants were asked to critique the image using the best practices guidelines they had just discussed, and make suggestions on how to explain the diagram to students or improve its appearance to make it more understandable.

Activity

Participants were encouraged to bring representations of their own that they had been using or were considering using in their own classrooms. A simple form with the best practices guidelines was made as a handout and the participants were encouraged to refer to them as they provided feedback on others’ diagrams.

References

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