Evaluation of the Methods Used to Present Concepts Related to Meiosis in a 2nd-year Undergraduate Genetics Laboratory.

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Because the lesson I have chosen is a laboratory session, most of the lesson relies on concepts from Social Development Theory and Constructivism. There are however a few places where Information Processing and Cognitivism are applied as well.

The lesson itself is broken up into 3 main parts (or chunks) because it spans a fairly long time period (about 2.5 hours). This segmentation is therefore used to give students some mental breaks between activities and to present and reinforce the information in different ways. In this paper, I will consider these three sections individually.

The first part of the lesson involves a brief lecture/discussion to introduce the terminology and basic concepts being taught. I tend to ask many questions when I teach and use student answers to lead to my next question – so, it's not necessarily a traditional university lecture. The “lecture” portion starts with a reference to my students' previous knowledge of mitosis (a related concept) and seeks to use that as a scaffolding to build upon. Similarities between Mitosis and Meiosis are discussed, and new terminology and stages are introduced along with explanations.

In this part of the lesson, I am acting as what Vygotsky would call a More Knowledgeable Other. I work to stretch my students' current Zone or Proximal Development to build a wider knowledge-base, from which they will be able to answer questions about Meiosis that can't be derived from just an understanding of Mitosis.

One of the places that I've noticed some application of Cognitive Theory is in my opening. In my lecture, I start by asking a provocative question: “why do we bother doing Meiosis? It's more complicated. Why can't we just clone ourselves (ie. Mitosis) and not bother with sexual reproduction?” Similarly, in the lab manual I wrote for this class, I present students with a problem before showing

them how meiosis solves it. In both cases I am getting the students' attention (and hopefully interest).

I use this method again about half way through the lecture to try to regain some of their attention when I tell them: “Right now, all of your Oocytes are stuck at Prophase I of meiosis. They have been stuck there since the day you were born...”. (All of my genetics students are female.) This leads to a discussion of the problems that can be caused by producing cells that are genetically distinct from the original cell, and makes the whole discussion more relevant to them – suddenly they're learning about themselves.

The second part of the lab is more self-directed. It allows students to apply the theoretical knowledge acquired in the previous section to an exercise where they are asked to identify the stages of Meiosis on microscope slides. This is a hands-on exercise where students are able to construct their knowledge. This exercise is also collaborative (important in both Constructivist and Social Learning Theories); students are able to discuss their thoughts with each other and solicit their peers' opinions, and also to ask the MKO (the instructor) to verify their stage identifications.

The final set of exercises involves group work. In this part of the lesson, students describe and explain the stages of Meiosis to each other in a small group. The challenge is that at the end of this exercise, they will have to explain it to the instructor, and the instructor can choose anyone in the group to present. Thus, each member of the group must be equally prepared. In this way, the stronger students in the group take on the role of the MKO to help some of the weaker students, and everyone gets to hear the story several times (possibly with corrections) – the repetition is used to help with the encoding of the information into long term storage. Over the course of this exercise, I have found that even some of the weaker students end up being an MKO by offering corrections to others. Additionally, all students are able to practice the Language of Genetics (as external speech) with the

intention that it will become internalized as a newly added part of their vocabulary.

This exercise is also organized based on the cognitivist principle of presenting information in a “spiral” where the exercises start by teaching a simple concept, and then build up complexity. The exercise is broken down into three chunks. The first just asks student to present the stages of Meiosis correctly. The two remaining parts of this exercise ask students to repeat their modeling of the Meiotic stages, but by having the students add a few minor components to their model each time, the students are able to visualize two important Laws of Genetics and thus gain a better understanding of them (instead of just memorizing their definitions). In the end, students are able to link what they learn about meiosis (a relatively abstract concept) to the more practical knowledge associated with the inheritance of genetic traits.

Overall, I am quite happy with the lesson in its current form, but there is room for improvement. One of the challenges I always seem to have is a lack of student preparation for the lab. This affects a student's information processing in that it lessens the amount of information that can be retrieved from memory and reinforced and increases how much of the material that I present is new (and thus the size of the “chunk” is larger). Also, having all students complete the assigned readings, puts them all on a more even footing in terms of background knowledge at the start of the lesson.

To this end, I think I might try to incorporate a Behaviourist approach and try to reward preparation in the form of marks from online pre-lab quizzes. Based on the fact that my students are very motivated by things that might affect their GPAs, I feel that this could have the desired result. These quizzes would be low-stakes and would allow students to check their answers before submitting them, thus they would be reading the required material.

This idea also fits well with Cognitive Theory where it would allow me to determine that students have the appropriate cognitive structures in place before they come to class. Similarly, in Social Development Theory, it is important for the instructor to be aware of the student's prior knowledge in order to determine the ZPD and provide scaffolding at the appropriate level.

Additionally, there is currently no reflection exercise associated with this lesson. Both, Cognitivist and Constructivist approaches recommend some form of reflection or summary activity to help with the encoding of new information. One good activity, could be asking students to link the chromosome modeling exercise to the generation of Punnett Squares – this would allow them link the stages of Meiosis, to the movement of chromosomes, to the distribution of alleles into gametes, to the determination of possible alleles produced by individuals when generating a Punnett Square.

Aside for the two main issues described above, I will also try to make a few smaller adjustments. I'd like to make the microscopy exercise a little more authentic (important in Constructivism and Situated Learning) by explaining to students why identifying meiotic stages could be useful based on my own research experience in a graduate research laboratory. I also plan to add more visual examples of the stages to my powerpoint slides to help reduce the cognitive load when students are learning about the different meiotic stages during the lecture portion.