Principle: "cause and effect" relationship between two or more concepts

Generally found in the sciences, but also may be found in social/work behavior

I want to speak on this slide show about our third and final project: which is developing a piece of a discovery lesson about a principle. So that means that I'll need to discuss principles, such as what they are and how we teach them in general. And then we will need to discuss how to construct a discovery lesson. And finally, when all of that is through, I'll mention the component piece that is your actual project. I think you will find that this assignment is shorter, and hopefully fun as well.

Let's first review what we learned last quarter. A principle is a relationship between two concepts. In most cases it is a cause and effect relationship, loosely defined. A cause and effect situation between concepts basically says that as we change one of the variables or concepts, there is an associated change in the other. For example, there is a relationship between temperature and the state of water. If we heat water that is as the temperature changes and raises the water will begin to boil. At some point, it will start to turn into steam. And if we go the other direction, as we change temperature and make it lower, water will turn into ice at 32 degrees.

Generally principles are found in the sciences--the classic hard sciences like physics and chemistry and also in the social sciences like psychology, sociology, and economics.

A word on the cause and effect thing. In some fields we have a pretty good sense of causality--like the effect of temperature on water. But in some fields, notably the social sciences, what really have are not quite as absolute. So these principles are more likely rules of thumb, or beliefs, of hypotheses that are currently accepted, in reality we don't always know the truth particularly well. For our purposes, and in Merrill's component display theory, a principle is just a relationship between two concepts that we will kind of pretend to be true. Without getting too philosophical, we don't always know the truth, but we teach principles generally as if they were the absolute truth.

Anyone who has ever done research knows that it is difficult to prove causality--and that sometimes we only know correlational data. We won't worry about that right now.
Principle of physics: lowering temperature lowers the am of a battery

Principle of economics: a lowered demand accompanied by no change in supply will cause businesses to lower prices

An increased demand accompanied by no change in supply will cause price to rise

Principle of sales: when a person has had good service, your business profits in the long run

Let's look at some examples of principles for a few minutes. Since I am asking you to develop a principle lesson at the use level, you need to make sure that you can find a principle. Here are a few examples:

Lowering the temperature of a battery lowers the milliamps of the battery. Heating the battery raises the milliAmps. But temperature doesn't affect voltage of a battery. I learned this a few years ago when my son did a science project in seventh grade. We froze a battery for a few days, and we took a battery and heated in for a few days and then we compared. And we learned a little principle of electricity.

The economics principle sometimes called supply and demand is really kind of a family of principles that relates supply and demand and price among other variables. The principle I have written here is not an absolute physical law, but rather a social science principle. It is what tends to happen rather than what absolutely must happen. In that sense, it is not exactly the truth, but it is a useful principle of
economics. It states that if we make too much of a product, and nobody wants it, then we will have to lower the price to get rid of it.

A second principle says that if there is more demand, and there is not enough supply to go around, then the price will raise—the idea behind scarcity. So these are complementary principles of economics.

The fourth principle is just a very loose and general principle: good service over time causes greater profits. Note that there is not a huge amount of scientific data that supports this, but there is a large amount of folks who believe in this principle. So a change in the quality of service—let’s say it gets worse, then a similar change should occur with the amounts of profits—it should also go down.
Assessment
• given cause(s) predict effect
• alter cause to produce desired effect
• given effect deduce cause

• provide explanation of behavior (which may require knowledge of other principles)

If we are teaching a principle, there are a few ways that a student can prove that he or she has mastered the principle. First, we can have the student state the relationship between concepts—that is the remember a principle level. But as you recall, we are not convinced that the student can do any more than recite some memorized words. The student may not really have a clue what the words mean. So therefore want the student to act—what we would call the use a principle level. Therefore, we might do a few different tasks. We could give the student a change in the causes, and then ask the student to predict the change in the effect. Another action might be to give the student the desired effect, and have the student manipulate a set of variables until it produces the desired outcome. Yet another activity might be to provide the student with the effect, and ask the student to deduce the cause.

A weaker and more questionable test of use a principle behavior is to have the student provide a verbal explanation of the cause and effect relationship.

Nonetheless, the first three seem to get at the use a principle level. We would expect that to be certain that the student is using the principle, and not just working from memory, we would try to show the principle in action in a variety of different scenarios, changing the irrelevant aspects of the situation—in a way, something like the way we taught concepts last quarter.

Teaching Principles:

Proposition: the statement or diagram that generally states cause and effect
Can be remembered, but that is not the same as being able to *use* the principle

**Examples:** specific instances of principle showing cause, effect and change

If concepts are not known, may need to be taught in parallel

When we teach principles we follow the general pattern that we have seen in much of component display theory: generality, examples, practice and testing. In particular the generality for a principle is called a proposition. It is the verbal statement of the principle. The phrases that were written on the last slide are propositions. They are simply the verbal statement, of the principle.

The proposition can be remembered--that is basically the skill at the remember a principle level.

Usually when we are teaching principles we show examples of the principle in use. That means that we show the cause the relationship being changed and then we see that the corresponding change also takes place in the effect. Sometimes it is enough to simply show that an act causes another act. The implied change in that case is that the absence of the act causes the absence of the result. For example, to illustrate the principle that guns kill people. we could show a person being killed with a gun. The change in the cause might be assumed that the absence of the gun causes the absence of the effect, sort of like: no guns cause people not to die. Of course, as I said earlier, not all principles are quite as simple as simple cause and effect In fact, if we took the opposite of this, it would, mean that the absence of a gun might bring people back to life--kind of like an un-kill principle or something. So when teaching the relationship it is important to make clear what we know and what the extent of the relationship really is.

If the cause concept and the effect concept are already known, then you really just need to show the relationship between them. Already known in this case means that each can be identified. If both concepts are no known, then each concept could be taught just prior to learning the principle.
Explaining an Underlying process:
detailed explanation of intervening events

• A process may have order and causality, too
• Explanation of underlying process may be helpful in learning a principle, but is not always required, unless objective is to "explain"
• Underlying process may not be known to learner or may need to be taught

Since this is a short slide show, let me take a moment to talk about a similar idea that is not part of component display theory. In CDT we have identified four major content types, facts, concepts, procedures, principles. And this generally accounts for the majority of instructional objectives that we might encounter. But there are two that are notoriously absent from CDT: process and problem solving.

We won't talk about problem solving here--but let's just say that it is generally a poorly defined outcome of a course or module. Problem solving doesn't seem to be a content type--it seems to be more of a generic skill that is learned and applied. Also, it doesn't appear to be something that you can learn in a short module--it is more systemic, and seems to be something that is learned over time.

But what does seem to fit into CDT is the idea of a process as a type of content. We might define a process as a procedure with causality, or as a set of linked principles. In any event let me try to describe what me mean:

If we wanted to learn about the digestive system in the body, we would find that different parts of the system have different relationships to each other. The teeth
masticate food, the mouth produces saliva to break down the food, the epiglottis keeps food from going into the wrong part of the throat, etc. This doesn't really entail a set of steps that the student could follow--it is a set of steps that leads to a goal, but it isn't a skill that a student could learn. At the same time, it seems to go beyond remembering the order of the steps. This is why I was always uncomfortable labeling these types of content as a procedure. It seems like if we "understood" the digestive system, then we might be able to state the order, but we might also be able to describe what would happen if the order were changed. Sort of like a cause and effect principle. So processes therefore have some of the characteristics of procedures and some of principles. There are many processes that we study and learn about. how a factory works, how acid rain occurs, the way that new products are introduced into a third world country. Some of these have multiple causes and cascading effects. That is, a first order effect combines with other factors and produces another effect.

In the case of a factory, we would probably say that someone understands the factory if her or she could describe the various processes that happen, and could tell us what might happen in we change a step or two in the process. Again we have that gray area between procedures and multiples principles.

Sometimes a principle is really an abbreviation for a complex process that underlies it. For example, to use my earlier example, I can settle for a simple principle that temperature affects the milliamperage of a battery. And I can learn to make fairly accurate predictions. But, really, I might not know why all of this happens--that is, I might not really know anything about the underlying process. IF I could describe the process that creates the principle, then it seems like I have learned a different skill.

Additionally, sometimes we might not really be able to describe the underlying process--or it may not be necessary for our objectives. But I think it is important to be able to describe the difference between using a principle (that is predicting an outcome) and describing the series of causes and perhaps the order in which they occur to make that happen (which I would call a process).

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Discovery Learning

Learning that takes place when students are is not presented material in final
form, but rather are expected to organize it themselves

Often means presenting a series of "dilemmas", problems, or situations and expecting students to extract the rule or principle from them

I think on one of the other slide shows I talked about the difference between discovery learning and expository teaching--or discovery versus a tutorial approach. For this project, we want to try a discovery approach to the lesson.

Let's start generally: discovery learning is Learning that takes place when students are is not presented material in final form, but rather are expected to organize it themselves

When we do this successfully, that presents a whole different approach to the design of CBT. Usually that means that we present a series of problems or situations that the student experiences in some way. Then, we expect the student to extract the principle from the examples. This contrasts with how we might design instruction in a tutorial mode, in which we would provide the proposition of the principle, then some examples, and finally some practice.

A General Model of Discovery Learning

1. Student experience

2. A hypothesis of the principle

3. A confirmation of the principle
4. Attempts to generalize

An extremely general model of discovery learning might consist of the following 4 steps: student experience, asking the student to form a hypothesis of the principle, then providing feedback and correction, and finally allowing the student to try to generalize the principle to other situations.

While this sounds very general, it is a pretty useful model to create a discovery situation’s What you will find is that it is, in many cases, harder to create a good discovery situation than it is to create a good tutorial. You will probably also find that it is much faster for a student to go through a tutorial. But, in an unknown percentage of the population, you will find that the really like discovery learning. Not everyone, mind you, likes it, but there is a group of the student population that finds it more enjoyable and motivating to discover for themselves.

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1. Student experience

The student is told to recall an experience, or the student actually encounters something new. This may be in the form of an experiment, a common occurrence, a set of historical events, etc.

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2. A hypothesis of the principle

The student is encouraged to measure and document the events. This may simply be a re-statement of what was seen or a systematic examination of data
The student is encouraged to formulate a proposition (hypothesis, rule, principle). Student may be asked to offer a plausible explanation for events as well.

3. A confirmation of the principle

The student is given the opportunity to test understanding in a new situation by applying the principle to (a) make a prediction or (b) create the effect by altering cause

4. Attempt to generalize

If proposition is correct, then student may be given additional events or situations to determine limits to the principle

Create a discovery environment

create example(s) that provide concrete opportunity to see the principle in action

help the student to formulate the proposition
Now, I hope that you are ready to put all the pieces together for a third project. What I want you to do is to create a discovery environment for a student. You don't need to develop all parts of the lesson, but you do need to create a piece of computer-based software that can be used for a student discovery experience. 

Let me try to give you an example: to teach the milliampere of battery and temperature principle, there might be any number of ways that I could go about doing it. One way to do this might be to let the student place some batteries in a variety of locations (of different temperatures,) and then have the student use a simulated voltmeter and ammeter (to measure volts and amps respectively) and to document what the student found. Now by forcing the student to systematically document the measurements, it becomes kind of obvious what is happening with temperature and amps and temp and volts. But this situation doesn't happen by chance alone--I have created the simulated world in which the batteries can be found. I have created a simulated thermometer, and various electrical meters. AND almost as important, I have created a set of documents for the student to systematically fill out with the findings. If I do all of these well, it should be fairly easy for the student to discover the principle for himself.

For this project, you don't need to produce the entire supporting lesson. You don't need to create practice, WIFFMs, and all of the rest of the module making material. Instead, I want you to focus on making a small learning situation. This will usually entail making a simulation of a process or finding a way to simulate a principle in action. And you should also include something that will help the student to document what he or she sees in your environment. Remember, the measuring and documenting of the experience will be what helps the student to discovery the principle.

The hardest part of this for many of you will be to find a principle that you understand, and that you can simulate. Principles are all around us, and they can be from the hard sciences or from the social sciences. But you will need to show the student changes in one variable and how it affects another. You can do this by having the student measure or otherwise document what is happening. And then you need to try to get the student to somehow form these observations into a statement of the principle.

Some of you will find this to be a short and easy assignment, while others will find this to be the most difficult. I am going to not say much more about this due to the shortage of time that many of you are now feeling. Please ask questions, and I will be glad to post answers or more material if you need it.

I do have an example of the milliamp discovery piece that I made last year--but I have to find it. SO look on the web site and I will try to post it in a couple of days if I can locate it.