The Evergreen Summer Institute
for College Teachers

DESIGNING INTELLECTUAL EXPERIENCE: A WORKSHOP ON WORKSHEETS

DEPAUW UNIVERSITY, JANUARY 16 - 18, 1984

SCHEDULE AND ROADMAP

TIME		
DAY 1		
9:00	INTRODUCTION	
10:00	INTRODUCTORY LECTURE	
10:30	BREAK	
	NEUTRAL SUBJECTS	YOUR OWN CONCEPTS
11:00	A. THE CANARY PROBLEM	D.1 p.1
12:00	LUNCH	
1:00	B. PUZZLING SCENES	D.1 p.2
1:50	C. CONCEPTUAL ANALYSIS IN A NEUTRAL SUBJECT	D.1 p.3
2:50	BREAK	
3:20	D. CONCEPTUAL ANALYSIS IN YOUR OWN SUBJECT	D.1 p.3
4:20	QUESTIONS ON THE DAY'S WORK	
Evening	E. ASSIGNMENT I	D.1 p.4

The Evergreen Summer Institute
for College Teachers

DAY 2

9:00 F. DECIPHERING AND ELICITING TEXT.....D.2 p.1

10:00 G. PUSHING STUDENTS INTO DISEQUILIBRATION (Includes 30 minute BREAK).....D.2 p.2

12:00 LUNCH

1:00 H. WRITING STRUCTURAL QUESTIONS.....D.2 p.4

2:30 BREAK

3:00 I. FIELDWORK.....D.2 p.5

4:30 QUESTIONS ON THE DAY'S WORK

Evening J. ASSIGNMENT II.....D.2 p.5

DAY 3

9:00 K. WRITING YOUR OWN WORKSHEET (Includes 30 minute BREAK)....D.3 p.1

11:30 L. TRYING OUT A WORKSHEET (Includes LUNCH).....D.3 p.1

2:30 FITTING WORKSHEETS INTO A COURSE

GENERAL DISCUSSION

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ROADMAP FOR WORKSHOP -- KEYED TO "STEPS TO WRITING A WORKSHEET"

NEUTRAL SUBJECTS	OWN CONCEPTS
I. PUZZLING SCENES	
Canary Problem **(A)**	Reflect on your own teaching. **(B)**
II. ANALYZE CONCEPTS	
Task in Baseball, family, and money **(C)**	Select and break down own Concept from (B) above. **(D, E)**
III. STUDENT CONCEPTIONS	
Text in Baseball, family, money. **(F, Part I)**	Think about your colleagues' conceptions. **(H)**
IV. STRUCTURAL QUESTIONS	
Writing Structural Questions about baseball, family, money. **(F, Part II,III)**	Do Fieldwork with your Structural Questions at the Workshop **(I)**
AND	
Section 1 of Nature/Culture **(G)**	
V. PLOT OUTLINE/WRITE WORKSHEET	
Sections 2 and 3 of Nature/Culture. **(G)**	Write worksheet draft for colleagues **(K)**.
	Try it out **(L)**.

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Day 1

DESIGNING INTELLECTUAL EXPERIENCE: A WORKSHOP ON WORKSHEETS

A. The Canary Problem (60 minutes)

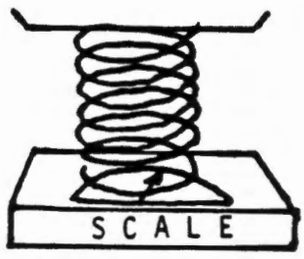
We have found that one of the most effective ways for teachers to increase student involvement is first to convert the products of their disciplines into processes for students and then to induce their students to go through these processes by setting problems for them. These are problems that first draw the students in at their present level of understanding and then, by progressive questioning, throw this understanding into a state of disequilibrium, a state which, when resolved, leads to new, deeper understanding.

1. Divide into groups of four and work at the following questions together. Appoint a scribe to record your group answers, so that they can be reported back to the entire group for a general discussion. (30 minutes)

a. A canary is standing on the bottom of a very large sealed bottle that is placed on a scale. The bird takes off and flies around the inside of the bottle. What happens to the reading of the scale? Explain.

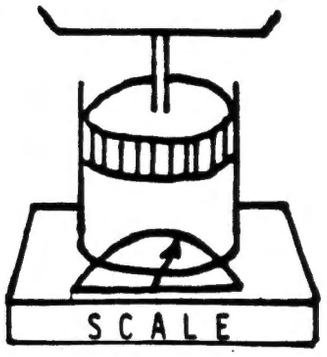
b. A goldfish is lying on the bottom of a large goldfish bowl filled with water that is placed on a scale. The fish takes off and swims around the inside of the bowl. What happens to the reading on the scale? Explain. How does this siutation differ, if at all, from the situation in a.?

c. A man is standing on a scale. He then gets off the scale, places a large spring on the scale, and stands on top of the spring. What happens to the reading of the scale? Explain. How does this situation differ from the preceding two?



d. Suppose the man in c. replaces

the spring on the scale by an "air spring." This is a cylinder with a piston that slides down into it. There is a column of air trapped in the cylinder, and the man stands on a platform mounted atop the piston. Compare the scale readings when the man is on the air spring as opposed to when he is directly on the scale. How does this situation differ from the preceding ones?



e. In the canary problem in a., suppose the bottle is replaced by a glass cage, which is mostly glass, but has very thin spaces between the glass bars. What happens? Suppose it is replaced by an ordinary wire cage. Suppose the bird is hovering over the scale and is not enclosed at all? What if the bird simply flies over the scale? Discuss.

[The above problem is an adaptation of a question raised in Conceptual Blockbusting, by James L. Adams, W. W. Norton & Co., New York, 1979.]

2. The entire group reconvenes to share answers and reach some consensus on them. (10 minutes)

3. Group discussion of the experience. (20 minutes)

B. Puzzling Scenes (50 minutes)

In the next few days you will be writing a worksheet which should generate the kind of puzzlement, sharing of views, and refinement of ideas we hope you have just experienced or witnessed in the Canary problem.

Think back on your teaching of your own discipline. Can you think of "puzzling situations," or "confusing concepts," or "paradoxes" that usually generate energy, frustration, or bafflement in your class? Such situations, which we call "Puzzling Scenes," are often the best places to start from in thinking about writing a worksheet. The puzzlement, confusion, and bafflement are signs that the students are already engaged in trying to understand, that the mental processes have already begun, but that the students need some guidance in enabling those processes to lead to an adequate understanding of the concept in question.

Describe, in writing, a few of these "Puzzling Scenes." For each of them describe in some detail the concept or problem involved and then tell what it is about the way students see things--the way they approach or conceive of the subject matter when they come to it--that leads to their being confused, puzzled, bothered, or energized by the situation. Then put yourself in a student's place and write out the questions that puzzle you (as a student) in these scenes. What are the questions you would like to have answered to cut through the confusion?

Spend about 30 minutes writing. There will be time at the end of the exercise for you to share some of it with your colleagues.

C. Conceptual Analysis in a Neutral Subject (60 minutes)

The goal of this exercise is to practice analysing concepts. Thus, you will begin with a fairly general subject, pull out its main concepts, describe how they are related to one another, and explain how they are central to the subject. You will be doing this later with concepts in your own subject. The three subjects are: baseball, the family, and money.

There is a section in Appendix 1, "Baseball, Family, and Money," on each of these subjects. First read the "Task" in each of these sections and decide as a group which subject you wish to work on. Then follow the instructions in that Task.

D. Conceptual Analysis in Your Own Subject. (60 minutes)

1. Set aside baseball, the family, or money for a while and go back to your own discipline.

You have taken the first step in preparing to write a worksheet in your own discipline in the writing you did on "Puzzling Scenes." The next step, which you will now undertake, is to analyze the concepts that lie behind those Puzzling Scenes as you analyzed baseball, the family, or money. Later on, you will share this work with a few colleagues.

Read back over the writing you did on "Puzzling Scenes," and select a Central Concept (or several) that underlie these scenes, that help make sense of them. Writing on your own, break down the Central Concept into a network of a small number of interrelated concepts, ones that are crucial for student understanding in the area. These concepts should be simpler or at the same level as the Central Concept, not more comprehensive and abstract than it. (30 minutes)

2. Share the results of your writing with other members of the group. (30 minutes)

E. ASSIGNMENT I.

The work you have done thus far toward writing your own worksheet is contained in the first two steps as outlined in Appendix 2, *"Steps to Developing a Worksheet."* Either by spending time at the end of the day, or at home, you should complete the second step, called "Analyze and Focus Your Central Concept." by selecting a Conceptual Goal. That is, you should focus down on a part of the network of subconcepts that could be worked on by your students in one or a few class sessions. It would be best if this is the part of the network that seems to give rise to the greatest puzzlement within your students, since that is the place where you are most likely to change their understanding.

Also, in preparation for the next few days work, you should look over the separate handout *"A Worksheet Sampler."* You will find there quite a diverse range of Worksheets in many subjects. We suggest you choose two sample Worksheets and study them in greater detail to get ideas for when you are writing "Structural Questions" or your own Worksheets. However, keep in mind that the Worksheets in the Sampler are all highly finished products -- the result of many rounds of tryout and revision. We do not intend that you imitate them on your first try.

F. Deciphering and Eliciting Text in a Neutral Subject (60 mins)

Later on you will be putting to your non-expert colleagues questions about your Central Concept(s). You will find in most cases that while they can give you answers to your questions, they cannot actually explain to you what they understand, or how their understanding differs from the way you, the expert, see things. Your job will then be to study their answers trying to figure out how they really understand the concept. This will require that you guess backwards from the text of their answers to their underlying beliefs. We call this activity "Deciphering Text," and think of it as similar to what employees of the U.S. State Department do with Soviet newspapers; they study the texts of articles in order to reconstruct the latest opinions of the Kremlin leaders. The purpose of this exercise is to give you practice at both Deciphering Text and writing the kinds of questions that elicit text -- what we call "Structural Questions."

In this exercise you will get practice at Deciphering and Eliciting Text in the same subject you worked on in "Conceptual Analysis in a Neutral Subject," yesterday, i.e. baseball, the family, and money. Unless you experienced some particular aversion to yesterday's subject, you should now form a group with the same people you worked on "Conceptual Analysis" with.

Part I. Deciphering Text (20 minutes)

In the "Text" of the section you worked on yesterday on baseball, family, or money there is a naive view of that subject, a way of looking at things that only an outsider would have. As you work over the Text you will probably find that the views expressed seem disconnected, illogical, perhaps simply wrong. However, we make the hypothesis that from the point of view of the person speaking, the ideas are quite logical and coherent.

> *Your job is to uncover and describe this point of view. That is, you need to describe a system of beliefs that makes the ideas expressed sensible. We call such a system of beliefs "STUDENT CONCEPTIONS." As you study the text, write down what you take to be the Student Conceptions behind it.*

Part II. Writing Structural Questions (20 minutes)

Now that you have clearer statements of the actual Conceptual System, on baseball, family, or money, of the person whose views you studied, your next job is to pose the kinds of questions that would elicit text like the material you started with. You want to write questions that will summon forth Student Conceptions more decisively, so that you can see and understand them more clearly. In almost all cases, you will find that the confusions are rooted in such problems as: mistakenly fused concepts, concepts that are artificially held apart, and concepts that are too rigidly applied. Appendix 3, *"Structural Questions"* is a guide to asking questions that get at these problems, and therefore, diagnosing Student Conceptions.

By reading Appendix 3 and studying the Student Conceptions you wrote down in Part I, write several Structural Questions that will help you get a clearer view of the naive beliefs you saw in your text.

Part III. Eliciting and Deciphering Text (20 minutes)

As a means of testing both the Structural Questions you wrote and your understanding of the text you studied, choose one of your members to role-play the author of the text. Then try out your Structural Questions on this naive person, one question at a time. Push it as far as you can into a full role-play to get a sense of the power and coherence of the naive views held by this person, as well as to see how the questions would be responded to.

G. Pushing Students into Disequilibration (90 minutes)

This exercise is designed to give you some practice with Steps IV and V of Appendix 2, *"Steps to Developing a Worksheet."*

Divide into groups of 4.

Read Steps IV and V of "Steps to Developing a Worksheet."

You will be working together writing a Worksheet designed for students in a course called "The Individual and Society." The Worksheet focuses on the concepts Nature and Culture. Students tend to think of "Nature" as being the expression of everything inside them, and "Culture" as being everything that is artificial and imposed from the outside. Many students feel that they, as opposed to their parents, lead lives that are quite "natural," and that with just a bit more effort they could reduce the

"cultural" proportion to a minimum. The object of the worksheet is to break down this rather simple-minded dichotomy -- to show that almost all of one's life is influenced by culture, and, in turn, our culture is influenced by our nature.

The Worksheet will have three sections. We have started the first two, and, in the material below, ask you to complete them. You will then be asked to decide on a focus for the third section.

<CAUTION: Don't get started actually working on this Worksheet on Nature and Culture -- engaging as it may be. Your task is to extend it.>

Section 1

The goal of Section 1 is to get the students to reflect on their own lives and to see how little of it could be classified as purely "natural." Section 1 starts as follows:

a) Consider a cat, or some other animal you have been around. My cat spends his day sleeping, eating, killing things, rubbing up against me and getting petted, fighting, mating, and playing. All of these are instinctively, biologically gratifying activities, pleasures in themselves (I assume). The only things he has been trained to do, and does for the sake of something besides the impulses of his body and its urges are meow to be fed, not to walk on the table, and relieve himself outside instead of in the house.

Individually, start at midnight yesterday or some typical day, run through your activities consecutively, and make a list of everything you do which is instinctively biologically gratifying, the way my cat's acts are. Anything that feels as though you do it in the way a cat eats or purrs -- some moments eating might count, for example, some might not.

How much time out of the twenty-four hours do these times involve?

Compare your estimates (but not the specifics of your activities).

1. Agree together on a series of questions to follow question a) above to complete Section 1 of the Worksheet you are writing. Your questions should build organically out of question a) and focus on the goal of Section 1 as formulated above. Try to write three to five questions that would take the students about 30 to 60 minutes to complete. *(30 minutes)*

Section 2.

2. Section 2 of the Worksheet focuses on the ACTIVE SUPPRESSION of the "natural" in our lives. Its goal is to help students see that not only is the natural ruled out of our lives in advance, but that when it threatens to intrude by accident, we take steps either individually or collectively to actively keep it out. A system of social and psychological controls operates to regulate and channel biological instinct and impulses.

Work together as a group to decide on a Concrete Context and an initial question or two about that context that will make a good starting point for this section. This time your task is not to sketch out the whole section, but to work just on the opening: the Concrete Context and the initial questions that will start the process of disequilibration.
(20 minutes)

Section 3

3. Your final step is to decide what Section 3 should be about. Go back and review the goal for the whole Worksheet, the subsidiary goals for Sections 1 and 2, and read over the questions you have produced thus far for the Worksheet. Section 3 should be a natural continuation and conclusion following Sections 1 and 2 and should help the students pull together the set of ideas from the whole Worksheet. The main task here is to agree as a group on the focus and goals of Section 3. If you have time, you can start to sketch a context and some questions.
(20 minutes)

4. The whole group meets together to share and discuss selected answers to the above three questions. (20 minutes)

H. Writing Structural Questions on Your Concepts (90 minutes)

In this exercise you will write the Structural Questions that will be used to Elicit Text from students (your colleagues in this case) on your own Central Concept(s). Thus you will be starting on Step III ("Describe Student Conceptions") of Appendix 2, *"Steps to Developing a Worksheet."* Your questions should be of the same kind as the questions you devised on baseball, the family, or money, and you will probably once again want to use Appendix 3, *"Structural Questions"* to get some ideas on how to write them. In the next exercise you will be using these questions to Elicit Text from your colleagues, in order to understand more clearly their underlying "Student" Conceptions of

your **Central Concept(s).**

Although writing Structural Questions is essentially individual work, we propose that you team up with a partner to do this work. After writing individually for about 30 minutes, you and your partner should share your work, helping one another refine it, and then go back to individual work.

I. Fieldwork on Your Concepts. (90 minutes)

Spend the next 90 minutes pairing up with various people (other than your partner) outside your discipline and interviewing them by means of the Structural Questions you just wrote. Use these questions informally, following them up with probes and qualifying questions in order to grasp as fully as you can how your "future students" initially understand the subject matter you will be teaching. Take turns, so that each person gets a chance to try out her questions. Try not to spend too much time with one person, so that you can get some diversity of views. Take careful notes on your "students'" responses, or use a tape recorder, so that you will have a text to analyze in order to describe your Students' Conceptions. The description of your Students' Conceptions will be an starting point of the Worksheet you will write and try out tomorrow.

As you put your questions to your colleagues, be careful not to try to teach them. You role in this exercise is very much like that of an anthropologist doing fieldwork. You want to find out what the "natives" think, without trying to change their views.

J. Assignment II

In preparation for the Worksheet you will write tomorrow, you will need to do two things this evening. First, you should review the Text you Elicited in "Fieldwork" today and write down a clear description of the Student Conceptions your worksheet will be directed at changing. Second, you should read Chapters V and VI of "Contexts for Learning." You may also find it helpful to read our paper "The Design of Intellectual Experience."

Tomorrow afternoon, we will discuss how to go about using Worksheets in a course. As preparation for this discussion, you should read from among Chapters VII through IX of *"Contexts for Learning,"* Appendix 4, *"Creating an Island of Change,"* and our paper, *"Teachers and Learning Groups: Dissolution of the Atlas Complex."*

K. WRITING YOUR OWN WORKSHEET (2 hours)

Your next task is to write out a Worksheet -- in the next exercise you will get an opportunity to try it out on your colleagues. Although this is individual work, you should do it seated near your partner, working with him or her in the same alternating pattern of writing and sharing that you followed in "Writing Structural Questions" yesterday.

The instructions for this exercise are to go as far as you can in Steps IV, V, and VI of Appendix 2, *"Steps to Developing a Worksheet."* If you find that you don't have enough time to write out a full worksheet, make you sure you get enough of one written out, so that your colleagues will have something to really engage with, and you can get a sense of how well your ideas worked.

L. TRYING OUT A WORKSHEET (2 hours)

Form into groups of three or four to try out your worksheets. In most cases, it is best not to have people in the same discipline in the same group. Also, in order to get new energy and new perspectives, people who have worked as partners should try to be in different groups.

Round 1. (1 hour)

One person in the group should volunteer to try out her worksheet on the others.

The author of the worksheet is to be an observer. She should pull her chair to the outside of the circle, observe carefully and take notes, while the others proceed with the worksheet. (Thus it would be best to select a worksheet that requires predominantly group discussion as opposed to individual writing.) For this part of the exercise THE AUTHOR IS ABSOLUTELY FORBIDDEN TO SPEAK EXCEPT TO ANSWER PURELY PROCEDURAL QUESTIONS. The group should spend about 30 minutes working the worksheet--don't necessarily try to finish it.

After the group has worked on the worksheet, the author should rejoin the circle for a general discussion of what she observed, and what the participants experienced in doing the worksheet. This discussion should run for the remainder of the hour devoted

to Round 1.

Round 2. (1 hour)

Another person in the group should volunteer to try out his worksheet, and following the instructions from Round 1, repeat the cycle of worksheet tryout and discussion.

Tasks and Texts: Baseball, Family, and Money

Baseball

TASK

Alphonso, an exchange student from Moravia, is living with you for six months. He has become fascinated with trying to understand the game of baseball. The three main sports in Moravia are soccer, tennis, and tag (which is played in a series of intricate variations). You and Alphonso have watched baseball games together on TV, but he consistently misunderstands the game, because he relates everything to the three sports he knows. So you undertake a more systematic approach to teaching Alphonso about the game of baseball.

As you begin the instructional sessions, you decide to think through how to do it. Before getting caught up in the rules, strategies, or subtleties of the game, it is a good idea to get clear on a few central concepts around which Alphonso can build his understanding of the game. These concepts will form the core of your teaching; they are the objects you set your sights on.

> *Describe a network of concepts that are central to an understanding of baseball. This network should consist of a small number of interconnected concepts (4-8) and should provide an underlying framework for understanding. However, don't spend time deciding on which concept is THE most important one. On the other hand, you should be able to tell how the concepts are related. As you think of the concepts, you might think of critical moments in the game that are described in terms of them.*

(TEXT on next page)

TEXT

The folllowing are comments made by Alphonso, the exchange student from Moravia, while watching his first baseball game.

a. I can tell that the man with the bat is trying to score a goal by hitting the ball into the scoring area -- which is between the two yellow posts and into the seats where the audience sits. The other team tries to get the ball to the opposite end of the field by throwing rather than hitting, but I still don't see where the scoring area for them is.

b. What is the point of all this running that the batting team does? They stay on and leave the field at the most peculiar times. They seem to be trying to get possession of the ball from the other team, but they don't always seem to have a bat to hit it with. They always run towards the ball; they always seem to know where the thrower is going to pass it off, even before he throws it, but they never seem to take it away. And they never run towards the pitcher, even though the ball always ends up being thrown to him.

c. The throwing team runs around a little, but not much. Some are bunched and others are spread out. Why don't they cover the field more evenly?

d. Some of the time everybody is in such a hurry to throw the ball or run, and other times they are so casual in both throwing the ball and strolling around the field.

e. What is the pitcher doing for so long each time before he throws the ball? Is he calculating strategy, trying to reach a decision, or what? Can he throw the ball anytime he wants?

f. Why is there no public clock to indicate when periods are over? How do they know when to switch without having a whistle or anything? And how long are the periods anyway?

Family

TASK

You are a member of a planning team for an interdisciplinary course on the Family, to be taught to college freshmen. Among the other team members are a sociologist, a psychologist, an economist, a historian, and an anthropologist. You all agree that the students will have a strong notion of what a family is, based on their own experience of growing up in one, and on images of the family depicted in the mass media (especially television programs). You agree that you want to considerably widen your students' views, but that you want to do it in such a way that they will be able to rethink their own childhood family experiences (and their TV watching) from these wider perspectives.

> *Describe a network of concepts that is central to a wider understanding of the family. This network should consist of a small number of interconnected concepts (4-8) which help explain the many functions performed by the family in all societies. However, don't spend time deciding which concept is THE most important one. On the other hand, you should be able to tell how the concepts are related, and give some examples of key aspects of family life that are explained by them.*

TEXT

These are the views of "The Family" as given by a 17-year old high school senior.

a. Your family's job is to take care of you until you're old enough to make it on your own. Sometimes, though, parents try to hold onto their children too long. They should let them go, when the children are ready. Otherwise children end up resenting their family.

b. When I meet the right person, I want to get married, because I think it would be wonderful to spend the rest of my life with the person I love. I want to have children, too. I'm not going to make the same mistakes my parents did. I'm going to make my home a fantastic place for for my children to grow up in.

c. A family should be the place you can always go to when you're in trouble or need help, no matter how old you are. You don't need to spend that much time with your family (once you're not a kid anymore), but it's important to know it's always there if you

need it.

d. Parents shouldn't try to impose their values on their kids. Times change too fast, and what was right for them growing up doesn't always work in today's world. Let the kids work it out for themselves. Families would be so much happier if parents didn't try to define and enforce right and wrong for their kids.

e. There is so much divorce these days, I think it's really tragic. The government is making a big mistake by letting people get divorced so easily. People should work their problems out instead of splitting up.

Money

TASK

Imagine that you are planning a course for Junior High School students in which the concept of money is to be studied. The students are likely to see money as the same thing as cash, and are unlikely to see the many functions performed by money in a complex society such as ours, or even a relatively primitive society. You want to give them a much wider, more integrated view of what money is and the purposes it serves.

> *Describe a network of concepts that is central to a wider understanding of money. These need not be (in fact, should not be) the concepts that economists would use. They should be the concepts that help you as an adult understand the concept of money better than the typical Junior High School student. This network should consist of a small number (4-8) of interconnected concepts which help explain the various forms money can take and how it works in an economy. However, do not try to decide which concept is THE most central one. On the other hand, you should be able to tell how the concepts are related and give some examples of key aspects of money that are explain by them.*

TEXT

The following are paraphrases of statements made by a twelve-year old child about money.

a. We can't use cans of mushroom soup for money, because not everyone likes mushroom soup, and so you would always have to bargain with it .... so that would be trading, and it wouldn't be buying. A dollar bill is worth a dollar, and everyone always knows it.

b. If an Indian tribe traded, and they wanted to have money instead, then they would have to have a government that made money. Then their money could be almost anything they wanted.

c. If they WANTED to have money, then the Indians in the Pacific Northwest couldn't use pine cones, because there are too many pine cones. The Indians in the desert could use pine cones, because there are not too many pine cones in the desert. But then maybe in some tribes you could use skins for money, if not that many Indians in the tribe hunted.

d. When the Indians used rabbit skins to get other things, it

wasn't money, because rabbit skins could be used to keep them warm, and you would want them more in the winter than the summer. They couldn't make wagon wheels into money either. We can't use our money for anything.

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STEPS TO DEVELOPING A WORKSHEET

Like any creative process, writing a worksheet can be done intuitively and can be done in a variety of ways. Moreover, the process can be entered from a number of points. We have outlined below the main steps in this process as we have followed them in this Workshop. But note, in particular that the early steps can be done in almost any order. What we do find to be important is that they all be gone through.

I. Recall Puzzling Scenes.

Puzzling Scenes are those times when questions lying within a subject spark a natural curiosity in students. This can be seen as energetic confusion, frustration to get at the real answers, or a feeling of paradoxical bafflement.

1. Recall exactly what went on publicly in these puzzling scenes.

2. Try to recreate the Puzzling Scene from the student's point of view. What was the concept involved; how do students see this concept; what kinds of questions would they ask about it, if they could get through some of their confusion?

II. Analyze and Focus Your Central Concept.

Whether you have chosen a Central Concept for your worksheet by recalling Puzzling Scenes or by thinking about the subject matter, you need to have a very precise understanding of the concept in order to work with it.

1. Break the Central Concept down into interrelated subconcepts and neighboring concepts. This Network of subconcepts and neighboring concepts should provide an underlying framework for the students' understanding of the Central Concept.

2. Either from your own imagination, or by recalling Puzzling Scenes, think of Concrete Contexts that exemplify the particular power of this Network of concepts. These Concrete Contexts should be "testing grounds" for the deeper problems in understanding this Central Concept.

3. **Select a Conceptual Goal.** Focus down to one particular part of the Network of subconcepts within the Central Concept and a few important Concrete Contexts, and think about one goal or one organized experience you would hold for your students with respect to this aspect of the Central Concept. What do you want your students to see, do, or understand differently about this Central Concept?

III. Describe Student Conceptions.

You need to be able to figure out approximately how your students think about the Central Concept, its subconcepts, and the phenomena it is supposed to describe. For this you need to do a kind of "fieldwork."

1. Write some Structural Questions you can informally put to students that will reveal their thinking in this area. (See additional handout on Structural Questions.)

2. Do some "Fieldwork." That is, put your Structural Questions from 1. to some students and elicit some text, text that you can then "Decipher" in order to be able to describe more accurately how your students understand the Central Concept. That, is, you want to describe their Student Conceptions. Either take notes on their answers or use a tape recorder to have a clear record of what your students say.

3. Study the text in order to decipher Student Conceptions about the concepts.

4. Review and perhaps revise your Conceptual Goal in the light of what you have discovered in 3.

IV. Formulate A Progression of Structural Questions.

These questions will be the skeleton for your worksheet. They require a Concrete Context, as well as several questions about that context which engage your students with your Central Concept and lead them to rework their thinking about it. These questions are a way of promoting the process of disequilibration, a process that will help them take apart their Student Conceptions and reconstruct new, more adequate conceptions in their place. These questions should have the following effect:

a. After the students have engaged with the scene, they will be puzzled, tweaked, or curious about the questions, because they mean something to the students.

b. But their puzzlement will not be quite resolved--they

will feel a little off balance.

c. A tension will be created by the questions that will motivate them to rethink some of their ideas. This tension derives from the partial inadequacy of their own ideas as to how to solve the problem.

d. The Progression of Questions will have enough intrinsic interest that the group will want to work together toward a resolution.

1. Formulate the Concrete Context with the Progression of Structural Questions.

2. Try out the Progression of Questions on a group of students. You act as much as possible as observer and take notes.

3. Revise the questions in the light of 2.

V. Write a Plot Outline for a Full Worksheet.

As with writing essays, outlines are not always necessary, but they are usually helpful to the beginner. The Plot Outline will help you articulate a direction for the worksheet, will insure that you have a beginning, a middle, and an end, and will help you articulate specific steps on the way to your goal. Here are some tips:

a. The worksheet should have three distinct phases characterized by:

ENGAGEMENT. Where the students' own ideas about the concepts are elicited and given a first testing.

PROGRESSIVE EXPLORATION. Where the students' ideas about the concept are further stretched, tested, and thrown into disequilibrium or conflict.

PULLING IDEAS TOGETHER. Where the students' new ideas about the concept are stabilized and integrated with old concepts.

b. It is helpful in the course of a worksheet to come at a set of ideas from many angles; one should avoid a monotonic or purely linear approach to the development of ideas. It is helpful to use several different contexts for the same concept.

c. If possible, the worksheet should allow students of diverse levels of understanding to interact with it, each in his or her own way.

d. The worksheet should not try to accomplish too much. It is better to allow for serious engagement and working out of ideas, which takes considerable time, than to try to cover a lot of ground.

e. Try to include a variety of modes of work, so that new energy can be generated as the workshop proceeds.

VI. Write the Worksheet.

You have already begun your worksheet with your Concrete Context and Progression of Structural Questions. Now you will fill out your Plot Outline in detail. As you write, keep constantly in mind both your Conceptual Goal, and your student audience and their Student Conceptions. At each step of the way you will have to ask yourself: How are my students likely to respond to this question? Is this question taking me toward my goal?

1. Write the worksheet.

2. Critique the worksheet with the aid of peers.

3. Revise the worksheet in the light of 2.

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Appendix 3

STRUCTURAL QUESTIONS

A Structural Question is one which invites the listener to actively use his or her Conceptual System on a particular phenomenon. Sometimes we use such quesions to get a clearer view of the listener's Conceptual System, sometimes to chan his or her Conceptual System, and sometimes to confirm and crystallize the Sysm. In any event, Structural Questions should depend as little as possible on memorization or matters of fact, convention, or pure opinion. We have found that the one certain way NOT to elicit an individual's Conceptual System is to simply ask for an explicit verbal explanation of the given concept.

To devise Structural Questions you must first focus on one Central Concept and understand the subconcepts that make it up, and the network of related concepts that surround it. In most cases, the Structural Question will not be felt as a question by the students unless you focus it down to a specific CONCRETE CONTEXT or contexts. Thus, you should also have a list of examples from the field of phenomena which the concept illuminates, particularly those that present particular difficulties as one applies the concepts to them.

The following is a partial list of strategies for devising Structural Questions, along with examples of each.

1. **Provide disparate examples of phenomena** for students to classify, order, or organize by the Conceptual System.

> "Which, if any, of the following are governments? NATO, a Public Utility District, the Communist Party of the USSR."

2. **Provide a counterexample, a borderline case, or an unusual example** for students to examine by means of the Conceptual System.

> "Charlie watches football for five or six hours every

Sunday of the footballseason. Would you say that Charlie is 'addicted'?"

3. **Introduce a new factor** into the field of phenomena and have the students trace out the consequences.

"Suppose a law were passed forbidding the use of students' college transcripts for job applications, grad school, medical school, etc. What would be the effect on colleges?"

4. **Provide an illuminating shift of context** which requires students to carry the structure of the Conceptual System across from one field to another.

"A small group is in many ways like a family, with the group leader playing the role of father. If this is the case, how is the 'mother-role' carried out?"

5. **Introduce a decisive conceptual distinction or a decisive conceptual connection** and have the students explore the effects of using the distinction or connection on the field of the phenomena.

"What are the differences and connections between the concepts 'career' and 'profession'?"

6. **Apply a transformation to the conceptual system** and have the students trace out the consequences.

"Imagine that, because of illness, a person loses 75% of the functioning of one of the following organs: Stomach, Liver, Kidneys, Pancreas, Intestines. For each of the organs describe the short- and long-term effects on the individual."

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Appendix 4

CREATING AN ISLAND OF CHANGE

The following are steps for converting a teacher's impulse for change into a new course activity to be carried out in a specific clearly bounded "place" in a course. We call this place, with its new activity, an ISLAND OF CHANGE.

1. Devise a changed activity for the teacher and students. This activity should be a significant realization of the teacher's impulse for change. It can be a new classroom format, a different mOde of evaluation, innovative homework assignments, a novel form of materials, or whatever seems appropriate. The best way to convert an impulse for change into a new course activity is to think about the attached list of teaching functions and ask which of these functions expresses the impulse and is not presently peformed by the teacher to her satisfaction. At this stage, do not worry about the feasibility or practicality of the changed activity; be guided by your fondest hopes.

2. Locate a limited and specific place in the course where the changed activity will be performed. Examples of such "places" are: Friday's lecture period, the four days preceding the midterm exam, every other laboratory period, student study sessions, the fifth and sixth weeks of the term, the last twenty minutes of three class periods a week. This specific place with its changed activity is the ISLAND OF CHANGE.

3. Decide what to give up. Introducing an Island of Change into a course inevitably requires that something presently in the course be given up. Decide what to give up, and make sure that it is not indispensible. A teacher who has trouble giving up anything should remind himself of the substantial gains the new teaching and learning activities will bring, and try again.

4. Clearly mark off the boundaries around the Island of Change. Since the Island of Change has been created to satisfy a teaching impulse which may differ strikingly from the impulses behind the rest of the course, the new rules set up within the Island may contradict the normal rules of the course. This will lead to mis

matched expectations and serious confusions unless everyone is crystal clear as to which rules hold in which parts of the course. Be explicit and systematic in marking boundaries.

5. Integrate the Island of Change into the course. The Island of Change will not work if it is felt to be an irrelevant adjunct to the course. After marking off clear boundaries among the different components of the course, and distributing teaching functions into them, make sure the whole course hangs together. A whole is not disturbed by having greatly modified parts, just as long as they work together. Here are some questions to ask to see if the Island of Change has been well integrated into the course.

> Can things be arranged so that the Island of Change is taken seriously?
>
> Is the Island made to count in the grading or evaluation system of the course?
>
> Is it of sufficient magnitude to warrant the students' effort?
>
> Does the Island of Change in any way seriously conflict with or undermine the values of the rest of the course?

The Island of Change is a device to allow teachers to introduce substantial new ways of teaching into their courses without threatening the entire course as it is presently taught. Over the long run, the creation of an Island of Change may be the first step toward a gradual restructuring of the course, or it may remain as it was first created. In either case the teacher has found a direct and explicit way to act on his or her original impulse for change.

TEACHING FUNCTIONS

1. PLAN STUDENTS' WORK

   Make up assignments
   Determine classroom activities
   Lay out projects
   Write tests

2. SUPPORT INDIVIDUAL STUDENTS

   Praise, reinforce students
   Bring out low participators
   Make sure students have had their questions answered
   Respond to and encourage students who are ahead

3. ASSESS STUDENT UNDERSTANDING

   Interpret mistakes they make
   Assess what they know and don't know
   Describe and analyze student belief systems

4. EVALUATE STUDENTS' WORK
   Grade tests, papers, projects
   Assign grades for course

5. SET AND CLARIFY LEARNING GOALS

6. INDUCE STUDENTS TO THINK

   Ask pressing and probing questions
   Get students to clarify what they mean
   Point out implications contradictions

7. HELP STUDENTS WORK TOGETHER

   Take account of differences among students
   Deflect questions to others
   Direct students to each other
   Group or regroup people
   Regulate pace of the class

8. ELUCIDATE SUBJECT MATTER

   Explain material
   Demonstrate procedures
   Summarize, crystallize, organize
   Give information and sources of information
   Give fresh perspectives
   Draw parallels, make connections

9. RESPOND TO STUDENTS' WORK

   Respond to written work
   Respond to oral work
   Make suggestions for revisions

10. DETERMINE RANGES AND LIMITS OF TEACHER'S AND STUDENTS RESPONSIBILITIES

11. HELP MOTIVATE STUDENTS

    Generate enthusiasm and excitement
    Boost morale
    Encourage groups