**E-Learning Design Principles, 05-823**

Professor Ken Koedinger, Human-Computer Interaction and Psychology

**Course Project Assignment for Fall 2014**

**Goals**: This semester-long project is an opportunity for you to *apply e-learning design principles and methods* in an extended project that *you define*. You will design an e-learning system for a curriculum unit in an educational domain you choose. The project has milestones with specified steps and due dates. In essence, these milestones are homework assignments that build on each other toward your final project. In *step 1*, you will pick a domain for your e-learning curriculum unit, answer some contextual questions, and identify relevant resources you will use in the design process. *Steps 2a and 2b* employ cognitive tasks analysis methods to precisely specify the educational goals that students should achieve from your curriculum unit. In *step 2a*, you will develop benchmark tasks and perform a rational cognitive task analysis as a first pass at goal specification. In *step 2b*, you will perform empirical cognitive task analysis (i.e., use data) to refine your goal specification and then summarize in a cognitive model that indicates what concepts, skills, and/or dispositions students should acquire from your e-learning unit. In *steps 3a and 3b*, you will employ e-learning principles to design instruction intended to help students as effectively, efficiently, and enjoyably as possible achieve the instructional goals from step *2b*. *Step 3a* involves designing assessments and materials by applying principles to enhance and explain your design. *Step 3b* involves further refinement, prototyping, and some initial student tests of your design. In *step 4*, you will design (but not run) a simple experiment to test whether one of your innovative principle applications does indeed enhance student learning.

I will ask you to *review other projects* as an opportunity for you to further reflect on and learn about the methods and principles this course teaches and to experience a wider set of e-learning design examples. This peer reviewing process will also provide you with a greater breadth of feedback on your project.

At the end of the semester you will *present your project* to the class and submit a *final write-up* of the project, summarizing the final design product and justifying the design decisions you made using the methods and principles you employed.

**Project Timeline**:

|  |  |
| --- | --- |
| **Project Step** | **Due Date** |
| **1: Domain, Context & Initial Resources** | Thursday, September 11 |
| **2a: Benchmark Tasks & Rational Cognitive Task Analysis**  **2b: Empirical Cognitive Task Analysis & Cognitive Model of Instructional Goals** | Thursday, September 25 |
| Thursday, October 9 |
| **3a: Assessment & Initial Instructional Design**  **3b: Instructional Design Prototyping & Testing** | Thursday, October 23 |
| Thursday, November 6 |
| **4: Research Design** | Tuesday, November 25 |
| **Class Presentations** | Weeks of Nov 20 and Dec 2 |
| **Final Project Submission** | Friday, December 12 |

The timeline is designed to allow two weeks for each step. You are required to submit a write-up and check-list for all steps. You will receive brief feedback on completeness of key items on steps 2a and 3a and more detailed feedback on steps 1, 2b, 3b and 4. You should use the feedback for project revision and development between steps. Course content will be synchronized to provide you with the concepts and skills relevant to each step. Getting an early start on the project, as the schedule requires, provides you with significant time for thoughtful refinement of the project along the way and for preparation of a presentation and complete project write-up during the final weeks of the term.

*Note*: If you are in 85-738 Educational Goals, Instruction, and Assessment, you will notice similarities in that project and this one. Dr. Carver and I highly encourage you to pursue the same project for both courses. But, you should know that there are requirements of this project (e.g., steps 2a, 2b and 3b) that are not requirements in 85-738 and requirements of that project that are not requirements here. So, *you cannot submit the same product* though there can be some sensible overlap.

**Project Step 1: Context & Initial Resources***Due Thursday, September 11*

The first step of the project involves answering basic questions (Who? What? Why? Where? and When?) regarding the educational design that interests you, as well as beginning to brainstorm the resources that are available to help in the design process.

*Context for your Educational Design*

* Who will you teach? Age range? Experience level?
* In what domain have you or other educators noted learning challenges, and which of them will your project target?
* What concepts, skills, and dispositions are central to what you plan to teach?
* Why is it important for them to learn what you plan to teach? How will it better prepare them, directly or indirectly, for future employment or better citizenship. If indirectly, how will it better prepare them for future academics.
* Where will you teach them? E-learning use from school, home, workplace, museum, or otherwise? In what subject area?
* When will you teach them? On your schedule (synchronously) or their schedule (asynchronously)? Anticipated length of instructional sequence? Estimated total time of lessons?

Don’t worry that you will be just making your best guesses when answering many of these questions at Step 1. You’ll have plenty of time to refine. Reviewing your best guesses will help me understand where you are in the learning process, so that I can help you formulate the context for a manageable project, given the course timeframe.

*Initial Resources Available*

* How much experience do you have in the project domain? As a student? As an expert? As a teacher? How much reading have you done about education in this area? List a few of the best articles.
* Do you know how this domain fits with the educational standards specified for the learners you intend to teach? If so, briefly describe them.
* Is there an educator in this area who can serve as a consultant to help you identify your target goals and the learning challenges in this domain, as well as reviewing your project design as it progresses?
* Are you aware of any educational materials (instruction and/or assessment) that have already been designed to teach this domain? List them, along with your opinion of their quality.

It is OK if are choosing a domain where you have not already done a lot of reading or design. What is most important is that it is a domain that you enjoy and one that you see value in teaching others. Having a good sense of the domain, even if you are not an expert, is also helpful.

**Project Step 2a: Benchmark Tasks & Rational Cognitive Task Analysis**   
*Due Thursday, September 25*

Steps 2a and 2b are a systematic method for specifying the *goals* of your curriculum unit.

In step 2a, you will select or create benchmark tasks and perform a rational cognitive task analysis. In step 2b, you will perform an empirical cognitive task analysis and summarize your results in a cognitive model specification. This cognitive model defines the instructional goals for your e-learning curriculum unit.

*Benchmark Tasks*

Come up with a set of tasks (or questions, problems, activities, designs, scenarios) that represent a span of what students should know and how they should be able to perform, reason, think, or even learn after having taken your unit. You should select or create *four or more tasks* that would take student about 20 minutes or so in total (e.g., a few minutes each) to complete. If your tasks are shorter, you may create more than four.

*Rational Cognitive Task Analysis*

Do some form of rational cognitive task analysis (CTA). You should at least complete the table below. You should also write an example of a desirable answer/solution to each of your tasks, including the reasoning steps you hypothesize are needed to complete the tasks successfully.

Kinds of learning goals students in your e-learning unit should achieve:

|  |  |  |
| --- | --- | --- |
|  | Cognitive | Metacognitive (thinking about the thinking/knowledge) |
| Concepts (Declarative) |  |  |
| Skills (Procedural) |  |  |
| Dispositions/Attitudes |  |  |

When completing the table above, some cells may have only one item indicated, but at least one cell should have a list of items (e.g., 3 cognitive skills).

Coming up with tasks and a desirable answer/solution and associated reasoning steps may be more difficult for less-structured or so-called “ill-defined” domains. If your project involves such a domain, you may want to both 1) be sure to not pursue too large a scope (e.g., you may want to limit your project to the most important or central aspects of the topic) and 2) consider specifying alternative answers/solutions to your tasks. The reasoning steps, especially the cues/conditions that drive decisions at each step, can be difficult to specify even in well-structured and well-defined domains. (This point is an important message of the course!) Do your best to hypothesize possible cues/conditions for decisions while being aware that your empirical CTA (step 2b) may change them.

Represent the results of your rationale CTA by using some cognitive process or structure representation, such as if-then production rules in English, a goal tree, flow diagram, skill hierarchy, semantic net, pseudo-code, production rules (e.g., in ACT-R or JESS), or some other AI or cognitive architecture. In any case, your rational CTA anticipates your final cognitive model and serves as hypotheses that you will check in the empirical CTA in the next step.**Project Step 2b: Empirical Cognitive Task Analysis & Cognitive Model of Instructional Goals** *Due Thursday, October 9*

In Step 2b, you will complete the cognitive task analysis (CTA) process by using the tasks you specified in Step 2a to collect (or compare to already collected) data through an empirical CTA. Using this empirical CTA, you will revise the hypotheses from your rational CTA and refine and elaborate your cognitive model specification.

*Empirical Cognitive Task Analysis*

Do some form of empirical cognitive task analysis, such as a structured interview, think aloud, difficulty factors assessment, or learning curve analysis (if existing log data is available). For interviews or think alouds, you should have two or more participants. For difficulty factors assessment or learning curve analysis, more like 20-40, but at least 10 participants are needed. Finding participants may be challenging. Be creative! Some suggestions for where to look: children of friends, relatives, faculty; children at a museum or park; college students; your fellow students in class. You want your participants to be as close to your target student population as possible, but someone who is not quite the right age (less important) or who does not have quite the right prior knowledge base (more important) is better than no one.

*Cognitive Model Specification*

The goal of your cognitive task analysis is to create a cognitive model of the desired knowledge components (i.e., cognitive structures or processes) that you want students to learn from your e-learning curriculum unit. You should specify these knowledge components in a summary representation of some cognitive processes or structures. Candidates include a goal tree, semantic net, flow diagram, production rules in English, pseudo-code, production rules (e.g., in ACT-R or JESS), or some other AI or cognitive architecture. If you want to use a different way of representing your cognitive model that is not in the list, please check with me. Explicitly indicate in your write-up what representation you are using.

In any case, be sure to focus on representing the knowledge components in your model in ways that research has shown to be central to the acquisition of expertise. For example, identify key features and meaningful patterns for the declarative information and emphasize deep understanding of concepts, rather than just listing facts. Be sure to specify the conditions for applying the skills you list, so that you will remember to focus both instruction and assessment on useful application and transfer rather than rote algorithms.

Your cognitive model representation is a quite detailed specification of the instructional goals of your curriculum unit – of what robust changes you want in student thinking. One extra consideration to keep in mind when analyzing your data and specifying your cognitive (and dispositional) model: How can you maximize the overlap between your goals and the learners’ goals so that you can tap their natural motivation? You want your course to be enjoyable as well as effective and efficient.

Reflect on your design for Steps 1 & 2a. Make any revisions necessitated by the decisions you made during Step 2b, as well as responding to the feedback you have received. Submit all three steps together so we can give input on the design as a whole.

**Project Step 3a: Assessment & Initial Instructional Design**

*Due Thursday, October 23*

In step 3a, you will expand your benchmark tasks to specify a complete assessment and, more importantly, begin the process of instructional design.

*Assessment Design*

You have already done work toward designing an assessment in your benchmark task creation in step 2a. To design a full assessment, you should first reflect on the results of your cognitive task analysis and modify your benchmark tasks. Next, you should indicate ways in which a full assessment (e.g., a end-of-unit test) would need to be elaborated to be complete. For example, indicate how your benchmark tasks could be varied so as to create other tasks that can be used on a full assessment.

*Instructional Design*

Begin designing instructional materials and activities by first providing a general description of your instructional approach, with justification based on scientific principles. Then offer more detail regarding specific activities that are key to the approach, together with an indication of the proposed sequence of activities.

Select *at least four principles* that will be part of your instructional design and pick at least one that you will target as more innovative (e.g., a principle that is not used or common in other existing course materials for your curriculum unit). For these four, you can use any principle from the Clark & Mayer book, any principle we have discussed in class, or any another established principle (but please check with me in this last case). For each of the four principles, use a specific task (could be one of the four from above) to give an example of how the principle is used in the e-learning curriculum unit.

Your write-up should clearly indicate what four principles you have employed, provide a description of the principle, and show and describe examples of each. For the one “innovative” principle that you chose, give an example of the student interaction *both* *with and without* applying the principle. Make sure your example is concrete (exact steps students taken in one case, but not in the other) about how your application of the principle changes the students’ experience.

Reflect once again on your design for Steps 1 through 2b. Make any revisions necessitated by the decisions you made during Step 3a, as well as responding to the feedback you have received. Please submit all four steps together so that I can give input on the design as a whole.

**Project Step 3b: Instructional Design Prototyping & Testing**

*Due Thursday, November 6*

This step gives you more time to further refine your design and perhaps reconsider your four principles, the primary innovative principle and the three other principles. You should create a low-fidelity (i.e., don’t worry about details), non-functioning (e.g., it can be sheets of paper) prototype of your design and test with some students (i.e., try it out!).

*Rapid Prototyping*

You should create a prototype or mock-up of your system in as fast and as simple way as possible. For example, it could be screen sketches on paper or in PowerPoint slides. Keep the scope small; for instance, you might pick one instructional activity and focus on the innovative principle. Of course, if your activities are quite short, like foreign vocabulary drill, or your innovative principle is about adaptive activity selection, then you should design a prototype for multiple activities (but focus on the transition more so than the content of the interaction).

*Student Testing*

Try your simple (paper) prototype with at least two people. To make this feasible, keep the design simple and be flexible (at least at first) about who counts as representative of a student. You did some recruiting of participants in step 2b, so try to draw from the same source (e.g., children of friends, relatives, faculty; children at a museum or park; college students; your fellow students in class). In the worst case, you might reuse some of those participants. As mentioned in step 2b, you want your participants to be as close to your target student population as possible, but someone who is not quite the right age (less important) or who does not have quite the right prior knowledge base (more important) is better than no one.

The primary goal of this initial test is to determine whether students will interact with your design in the way you expect. Be skeptical about your design and watch carefully. You want to find what is not working so you can improve it.

How can you have someone test a paper prototype e-learning system that has not been implemented? The simple idea is to have a series of screen images that anticipate the desired interaction steps. You show the participant the first image (put a page in front of him or her) and ask what he or she would do. If the student does as you anticipate, you have the screen that will result ready and present that. If he or she does not, you record this miss-step (your fault, not the students!), indicate to the student what you intended, and show the next screen. Repeat.

Your write-up should include your prototype (screen images) as an appendix. It should summarize your participants and indicate what happened with the first participant, how you revised the design, what happened with the second, and how you revised again.

As usual, hand in a cumulative write-up that appends the result of this step, but also includes revisions to past steps based on feedback.

**Project Step 4: Experimental Design***Due Tuesday, November 25*

In step 4, present the design of an experimental investigation that you would propose if you wanted to demonstrate (to your company and your customers) that your e-learning product is not only innovative, but effective in enhancing student learning. This experiment may simply be a contrast between your e-learning unit with and without the innovative principle you indicated in step 3a. In industry terms, this study is an “A/B test”.

Provide answers to these questions:

* How would you measure learning (e.g., a pre- and post-test)?
* How many participants? How you would recruit them?
* Where would participants use your system (e.g., in school or anywhere online) as well as your measures of learning (e.g., on paper, an interview, or also online)?
* How much you assign participants to use the treatment version (with innovative principle) and/or to use the control version (without the innovative principle)?
* What log data would you collect to use to (among other possibilities) check the extent to which participants engaged in your treatment as intended (e.g., if they were to study worked examples, did they?)?
* What results do you expect?

Reflect once again on your design for steps 1 through 3b. Make any revisions necessitated by the decisions you made during step 4, as well as responding to the feedback you have received. Please submit all six steps together so that I can give input on the design as a whole. Then begin considering how you will present the key points of your project to the group to get input from others involved in a similar process.

**Project Presentation***Weeks of Nov 20 and Dec 2*

Details of project presentations will be provided later in the course. A possible scenario is you create a poster, present to the whole group in a fast 2-minute “firehose” presentation, we have a poster session (e.g., with 6 posters per class period) where you answer questions, and we end with some whole group reflection.

**Project Final Report and Reflection***Friday, Dec 12*

Your final project report should incorporate feedback from step 4, feedback from your presentation, and include any final refinements and improvements.

*Reflection*

Your report should end with a reflection section that summarizes your project and includes your self-evaluation of it.

* What are three key lessons you learned?
* What challenges did you face?
* How did you overcome them and/or why do some remain?
* What are your next steps, either with respect to this project if you plan to continue it, or with respect to other projects that could benefit from this approach?
* The next time you have an opportunity to begin a new project, how do you plan to proceed differently?