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

Professor Ken Koedinger, Human-Computer Interaction and Psychology

**Course Project Assignment for Fall 2016**

**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. These milestones are designed to keep you on track and to build on each other toward your final project.

**Project Timeline**:

|  |  |
| --- | --- |
| **Project Step**  | **Due Date** |
| **1: Context & Initial Resources**  | Thursday, September 15 |
| **2: Identifying Goals & Online Assessment Creation** | Thursday, September 29 |
| **3: Cognitive Task Analysis & Cognitive Model** | Thursday, October 13 |
| **4: Initial Instructional Design**  | Thursday, October 27 |
| **5: Instructional Design Prototyping & Testing** | Thursday, November 17 |
| **6: Experimental Design** | Tuesday, November 29 |
| **Class Presentations**  | Nov 29, Dec 1, and 6 |
| **Final Project Submission** | Monday, December 12 |

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. In *step 2,* you will specify the educational goals that students should achieve from your curriculum unit. You will also design and implement an initial online assessment or quiz. In *step 3,* you will employ cognitive task analysis methods to precisely specify the educational goals that students should achieve from your curriculum unit. A rational cognitive task analysis provides a first pass at goal specification. Then, an empirical cognitive task analysis (i.e., using data) will refine your goal specification and help you develop a “cognitive model” that indicates the concepts, skills, and/or dispositions students should acquire from your e-learning unit. In *steps 4 and 5*, you will employ e-learning principles to design instruction intended to help students learn as effectively, efficiently, and enjoyably as possible to achieve the instructional goals from step *3*. *Step 4* involves applying principles to instructional materials and activities to enhance and explain your design. *Step 5* involves further refinement, prototyping, and user testing evaluation of your design. In *step 6*, you will design (but not run) a simple experiment to test whether one of your innovative principle applications does indeed enhance student learning.

 I may ask you to *review other students’ project progress* as an opportunity for you to 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 review 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.

 The timeline is designed to allow two weeks for each step. For each step, you are to submit a write-up addressing goals for that step and including any revisions on prior steps. You will receive brief feedback on your progress and guidance about what to improve. You should use the feedback for project revision and development between steps. Course content is intended to provide you with the concepts and skills relevant to each step. If you are unsure about how to perform a step or about the relevance of a method or principle discussed in class, ask us -- you are ultimately responsible for what you learn and produce. 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 taking 85-738 Educational Goals, Instruction, and Assessment, you will notice similarities in that project and this one. Dr. Carver and I allow and even encourage you to pursue the same project for both courses. But, you should know that there are requirements of this project (e.g., steps 2, 3 and 5) that are not requirements in 85-738 and requirements of that project that are not requirements here. So, *you cannot submit the same final product* though there can be some sensible overlap.

**Project Step 1: Context & Initial Resources***Due Thursday, September 15*

The first step of the project involves answering some basic questions regarding the educational design that interests you. It also involves searching for resources to help you in the design process. ***Important tip for selecting a project focus***: Finding participants for later steps in this project (e.g., for interviews, cognitive task analysis, and student testing) is a challenging element of this project. Unless you already have your own good access to appropriately-aged students, seriously consider picking a topic that is relevant for college-aged students. Such students, including classmates, will be easier to find.

*Determining the Context for your E-Learning 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 students 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.

*Identifying Resources to Aid your Design*

* 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.
* Identify one or more experts or educators 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.

**Project Step 2: Identifying Goals & Online Assessment Creation**

*Due Thursday, September 29*

Step 2 starts a process of applying methods toward more systematic, complete, and well-specified course goals. You will not only describe the goals in words (often easier), but also design and implement prototype assessment tasks (e.g., quiz or test items or performance tasks) for those goals.

*Use Resources to Identify Learning Goals and Assessment Tasks*

To start goal specification, you should first consult the resources you identified in Step 1, including existing course materials, existing standards, experts, and your own expertise. Use these resources to both to achieve the goals described below, to identify learning goals to place into the table below, to identify assessment tasks, and to implement some of those tasks in an online assessment tool. This step will be greatly enhanced if you can perform some kind of *structured interview* (a Clark-style cognitive task analysis) or *contextual inquiry* with an expert (or any skilled individual) your area of interest.

*Create an Assessment Framework Table*

Using your resources, complete the table below by entering in each cell one or more learning goal appropriate for your unit. For now, try hard to have at least one entry in each of the six cells and at least one cell with multiple entries (e.g., 3 cognitive skills). You are likely to focus on just a few of these goals in subsequent steps, but it is a good exercise at this point to fill all the cells.

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, some cells may have only one item indicated, but may have more (e.g., only 1 metacognitive disposition, but 3 cognitive skills). For each goal, indicate which resource you used (existing course materials, existing standards, experts, or your own expertise) to come up with that goal. You can use superscripts to indicate the resource(s) used for each goal.

*Design Assessment 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 a set of tasks that would take students *about 10-20 minutes in total to complete*. That could be, for example, 20 short tasks that each take 30-60 seconds to complete or 2 long (performance) tasks that each take 5-10 minutes. For each task, indicate *the* correct answer in the case of a closed-response question (e.g., multiple choice) or *a* correct in the case of a constructed response or an open-ended question (e.g., a performance task).

 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.

 In general, think about how you could tell whether a student has achieved a goal. What could you observe a student doing that would indicate they have mastered, or at least improved on, a learning goal? What could you ask them (e.g., a question or a scenario with a decision point) that would elicit the behavior? What would you look for in their behavior that would indicate mastery or improvement?

*Implement Tasks in an Online Assessment Prototype*

A good way to start implementing an e-learning unit is to start at the end! That is, start by implementing an assessment that makes your learning goals concrete, serves as a target for your instructional design, and provides a means for empirical cognitive task analysis. Different software options for you to use to implement an online assessment include (for some, listed first, we can provide more support whereas for others, listed later, you will be more on your own):

* Cognitive Tutor Authoring Tools or CTAT (get from [ctat.pact.cs.cmu.edu](http://ctat.pact.cs.cmu.edu/)) allows for drag-and-drop creation of an interface that can mimic an open-ended problem solution. Look for documentation on creating online quizzes. We can guide and support you with this tool.
* Blackboard () provides a set of alternative item types including multiple choice, matching, ordering, fill-in-the-blank, essay, hot spot (in images), jumbled sentence, etc.. We will provide you with a Blackboard course account if you want to use this option. Support available.
* ASSISTments Builder ([assistments.org](https://www.assistments.org/)) allows for fill-in-the-blank and multiple choice items, which can be followed by more diagnostic questions. Some support.
* Google forms ([www.google.com/forms/about/](http://www.google.com/forms/about/)) provides options for multiple choice, multiple answer, short answer, scale and grid. Similar tools include Open Assessments (<http://www.openassessments.org>) and Onyx-editor ([onyx-editor.org](https://www.onyx-editor.org/)). Limited support.
* Bazaar ([www.cs.cmu.edu/~dadamson/bazaar/](http://www.cs.cmu.edu/~dadamson/bazaar/)) and other tools by CMU [Prof. Carolyn Rose](http://www.cs.cmu.edu/~cprose/Projects.html) process student essay (natural language) input.
* Other possibilities, some of which may require purchase: Moodle, Survey Monkey, Qualtrix, [Adobe Captivate](http://blogs.adobe.com/captivate/2015/08/introducing-adobe-captivate-draft-storyboard-and-design-elearning-on-your-ipad.html), … You’re mostly on your own if you choose one of these.

You can make revisions to step 1 at this point. Submit the two steps together so we can give input on the design as a whole.

**Project Step 3: Cognitive Task Analysis & Cognitive Model of Instructional Goals** *Due Thursday, October 13*

In Step 3, you will conduct rational and empirical cognitive task analysis (CTA) using (and perhaps extending) the tasks you developed in Step 2. In a rational CTA, you will try to specify the underlying cognitive processes (or knowledge components) that need to be learned to perform successfully in your domain (i.e., to perform successfully on the tasks you have specified). Then you will perform some form of empirical CTA to revise the hypotheses from your rational CTA and refine and elaborate your cognitive model specification.

*Rational Cognitive Task Analysis*

For each of the tasks you have developed, indicate the reasoning steps you hypothesize are needed to complete the tasks successfully. 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 may change them.

 Represent the results of your rational 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, pseudocode, 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.

*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, whether face-to-face or online, is challenging. Be creative! Some suggestions for where to look for face-to-face participants: your fellow students in this class; children of friends, relatives, faculty; children at a museum or park; college students. To find participants online, you can post a link to your online assessment on a relevant web page or even use Amazon Mechanical Turk. 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 & 2. Make any revisions necessitated by the decisions you made during Step 3, 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 4: Initial Instructional Design**

*Due Thursday, October 27*

In Step 4, you will improve your assessment design and begin instructional design.

*Expanding and improving on your Assessment Design*

Use the results of your CTA, to improve your assessment design and online prototype from step 2. Try to implement a full assessment (e.g., a end-of-unit test). At least provide a design for a full assessment indicating the items or kinds of tasks that you would need to add.

*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 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 3. Make any revisions necessitated by the decisions you made during Step 4, as well as responding to the feedback you have received.

**Project Step 5: Instructional Design Prototyping & Testing**

*Due Thursday, November 17*

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 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 3, 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 3, 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 you present that screen to the student. If he or she does not, you record this miss-step (your fault, not the student’s!), 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.

 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 6: Experimental Design***Due Tuesday, November 29*

In step 6, 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 4. 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 5. Make any revisions necessitated by the decisions you made during step 6, 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**Nov 29, Dec 1, and 6

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 5 posters per class period) where you answer questions, and we end with some whole group reflection.

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

Your final project report should be written as clear, professional, engaging write up that presents a compelling case for why your e-learning unit is great! Your final report *should* ***not*** *be a collection of answers to all prior questions*. Highlight the most important and interesting elements and the research that went into its creation. Clearly present the *what* and the *why* of your project. The *what* is the content and design of your e-learning unit. The *why* is the science behind its creation -- how the methods, such as cognitive task analysis, and the principles informed your design and made it better. Incorporate feedback from all prior steps, 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?