INTERACTIVE WEB-BASED INSTRUCTION: WHAT IS IT? AND HOW CAN IT BE ACHIEVED?

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Today, the use of the Internet to teach university curricula is common place. However, few theory-based guidelines have been published to support course authors as they attempt to move their teaching out of the traditional classroom and into cyberspace. In addition, issues and trends discussed in literature across a number of disciplines indicate that there is a critical need for web-based courseware to be interactive.

However, a concise definition of interactivity does not exist. The goal of this article is to provide interested readers with a model for achieving interactive web-based instruction. The model includes a possible definition for interactivity called *adequate dialogue* and a description of courseware components that successfully increase interactivity and learning outcomes based upon this definition.

Course authors may decide to adopt these same interactive components or choose new ones that meet the criteria of adequate dialogue. The model is the result of the author's work on a grant at The University of Arkansas, Fayetteville (UAF), which included the design, development, and evaluation of two undergraduate web-based distance education courses.

A blend of qualitative methods that included document analysis and interviewing were used to evaluate the UAF courseware; analysis of the data that employed data and investigator triangulation indicated that the author's model is worthy of replication. *To navigate to and from the text of this article to the illustrations and graphic examples provided via hyperlinks, please use the back button on your browser. This article was formatted to allow readers with older browsers to view all of the content.

Defining Interactivity for Web-based Instruction: A Synthesis of Perspectives

The following definition of interactivity was taken from two sources: Moore's (1990, 1996) theory of *transactional distance* and Laurillard's (1993) discursive, adaptive, interactive and reflective *conversational framework*. Moore's concept of transactional distance describes the nature of distance in educational settings. Laurillard's conversational framework discusses the character and complexity of academic learning, the roles of students and teachers in the learning process, and the strengths

and weaknesses of various technological mediums as support mechanisms for those roles.

Since computer and web-based instruction may be considered a type of distance learning where direct access to the teacher is limited, the definition of interactivity described in the next few paragraphs may be applied to any web or computer-based courseware. Direct access may be limited because the teacher is not present in person or the content is presented in an artificial environment that is incapable of flexible, expert reasoning. For example, SimCity allows students to manipulate various factors that impact city planning, but the computer's responses are limited (i.e., the program itself allows only a select number of student choices and program responses). This is an example of an artificial environment. Direct access to an expert in city planning would obviously give students an opportunity to gain more insight.

Briefly, Moore (1990, 1996) detailed three different types of interactions which he argued are essential to distance education:

1. learner-instructor interactions (the component in his model which provides motivation, feedback, and dialogue between teacher and student)

2. learner-content interactions (the component in his model through which students may acquire facts)

3. learner-learner interactions (the component in his model through which students exchange and sharpen subject-related knowledge)

McIssac and Gunawardena (1996), who discussed Moore's theory at length, made an important point. They stated that highly structured course content decreases the dialogue between students and instructors, whereas less structured course content increases that dialogue. This statement implies that teachers and/ or instructional designers can help students who are learning at a distance by: thoroughly structuring content and providing mechanisms that support all of Moore's interaction types.

Laurillard (1993) added depth to Moore's theory by stating that all teachers must recognize the special character of academic knowledge while encouraging dialogue between the teacher and student that is discursive, adaptive, interactive and reflective. Daniel (1996) summarized Laurillard's conversational framework by defining her terms and by presenting a concise graphic illustration of her ideas in action.

Please click here to view a version of this graphic developed by the author.

In addition to her conversational framework, Laurillard (1993) also provided a media comparison that detailed the strengths and weaknesses of various types of media as support mechanisms for the twelve steps of discourse responsibility she described. Her twelve steps represent a more detailed

description of what Moore's interactions might look like when actually applied.

Please click here to view a graphic illustration of Laurillard's media comparison developed by the author.

This graphic also rates the level of interactivity of Laurillard's media types.

Combined, Moore's (1990, 1996) theory of transactional distance and Laurillard's (1993) conversational framework provide a possible definition of the concept of interactivity that may be described as adequate dialogue. Adequate dialogue may be established by using instructional techniques or technologies that fit within Moore's theory of transactional distance, while fulfilling at least eight of Laurillard's 12 conversational framework guidelines.

Please note that an instructional environment that meets eight of Laurillard's twelve steps falls at the halfway point between establishing a high level of interactivity and remaining static.

Choosing Effective Interactive Components

Too often, web-based courseware is extremely limited and relatively static because the course author has not taken the time to establish a method for choosing interactive components. This article proposes that if one has first defined interactivity, then one has established a method for choosing interactive components. Further, much web-based instruction is also limited because it is primarily text-based.

(Please note that print-based content is rated as static by Laurillard.)

The UAF grant courseware was designed around a textbook metaphor in which opportunities for interaction were afforded through a Netforum (a threaded email forum), the visualization of key concepts, and concept mapping. Four components supported student-to-content interactivity as described by Moore: 1) animations, 2) hotspots/rollovers, 3) thought questions, and 4) animated hotspots/rollovers. One component -- concept mapping -- supported adequate dialogue as described earlier by providing for instructor-to-student, student-to-student, and student-to-content interactivity.

Each of the two undergraduate courses described above contain a total of eight content modules;

please go to: **http://www.uark.edu/campus-resources/anscmatr/demonstration/physiology/index.html** to view an entire module.

These two poultry production courses cover all aspects of poultry production, from hatchery to processing. The first course, **POSC 2353 Broiler & Turkey Production** was launched during Fall

2000.

The second course, **POSC 2363 Breeder & Layer Management** was launched January 2001. Although the description that follows is stated in the past tense, each of these courses are currently active and will continue to by offered and taught with only minor alternations.

The Netforum was supplied to give the teacher a mechanism to provide support for student-to-student and student-to-teacher interaction. Animations and animated hotspots were included to emphasize key concepts such as the ones shown in **poultry physiology temperature regulation**: please click on **vasoconstriction** and **vasodilation** to see examples. Hypertext pop-up interactions allowed students to explore important terms and definitions. Please note: the layers shown in the following linked graphic may not work with older browsers, you may also need to adjust your text size down for this page to operate correctly. In addition, when your cursor passes off the terms shown with this graphic the explanation will disappear. Further, after exploring this link you will need to click the back button on your browser several times to get back to this article.

Please click here and explore this hyperlinked paged for a demonstration.

Hotspot/rollover interactions were provided to increase student engagement and interest in complex scientific phenomena. An excellent example of this technique is shown in the interactive graphic representing the thermal environment of poultry.

To view this example please click here and explore this hyperlinked page.

This graphic illustrates behavioral and physiological changes in poultry due to temperature shifts. Thought questions were included to create periodic opportunities for students to reflect on the content materials. Thought questions were imbedded within the content as shown on this sample page; **please click here**.

The answers were hyperlinked to support the student. The hyperlinks were activated by a mouse click that launched a second pop-up browser window which revealed all of the thought question answers within that particular module.

(For readers who do not have Internet Explore or Netscape 4.0 and above please click here for an illustrated description of all of the courseware components described above via hyperlinks.)

You will need Acrobat Reader to view this hyperlinked file.

With regard to the choice to use animations and hotspots/rollovers, two separate bodies of research and corresponding literature revealed that the visual representation of information is a necessary pedagogical element. The first body of research is visual literacy, the second is within semiotics, critical theory and ethnographic studies. In 1996, Braden detailed Paivio's 1971 Dual Coding Theory

of memory and cognition in a discussion on the impact of graphics and illustrations in textbooks. In essence, Dual Coding Theory postulates that humans encode both verbally and visually, and that verbal concepts are hung on nonverbal pegs in memory; i.e., imagery is the effective variable in recall of concrete verbal information. Furthermore, in 1982, Levie and Lentz provided an outstanding review of the research on the effect of illustrated texts on learning by summarizing the results of 155 separate experimental comparisons of learning from illustrated versus non-illustrated text.

Forty-six of those (155 studies) studies compared learning from illustrated text material versus (learning) from text alone. In all but one of these 46 cases, the group mean for those reading illustrated text was superior to that of the group reading text alone...in 39 of the 46 comparisons, the difference was statistically significant...and the average group score for the illustrated-text group was 36% better than for text-alone groups (Levie & Lentz, 1982, p. 198).

Concept mapping was chosen as the component to establish adequate dialogue because it has been successfully used as a tool to help students to reflect upon, reorganize, and integrate existing and new information into meaningful application (Novak & Musonda, 1991; Pfundt & Duit, 1994).

To view a concept mapping exercise please click here.

Concept maps graphically illustrate relationships between ideas and greatly aid students in the process of restructuring their own knowledge and/or expanding their own conceptual understanding. Within a concept map, two or more concepts are linked by words that describe their relationship. A concept is "a perceived regularity in events or objects or records, designated by a label" (Novak & Wandersee, 1990, p. 29). For example, "free fall is due to gravity" could be described with a concept map containing two ideas: free fall and gravity (which both appear in symbols), and three linking words: "is due to". To view an example of a concept map specific to UAF grant courseware content **please click here**: to view **a detail of the map please click here**. (The detail is included because the whole map is difficult to view in its totality.)

The Results of the Research Stage UAF Study

The results of the research stage of the UAF grant project suggest that the combination of interactive components chosen for inclusion in the undergraduate courseware provided effective web-based instruction. Animations, hotspots/rollovers, thought questions, and animated hotspots/rollovers helped to clarify and emphasize content for students and concept mapping exercises forced students to articulate and reevaluate their knowledge.

Twenty-one students volunteered to contribute to this case study by completing pre- and post-content knowledge concept mapping exercises; six students were chosen to participate in the nominal group interview process based upon their pre-content knowledge concept mapping exercise performance. A quantitative scoring scheme designed by Novak and Gowin (1984) to evaluate pre- and post-content knowledge of poultry physiology as shown in concept maps as shown in Table 1. Changes in concept mapping scores are shown in Table 2. This study however, did not establish the

reliability and validity of the content expert map or student maps, therefore concept map scoring data was analyzed from a qualitative rather than a quantitative viewpoint.

Table 1.
Concept Mapping Scoring Scheme

Category	Possible Answers	Points Value highest	Possible
Valid Relationships	55	1	55
(Conceptual) Hierarchy	13	4	52
Cross Links	14	10	140
Examples	30	1	30

Note. The number of possible answers for each category was established using the expert concept map as a guide, however it is important to note that the expert map was not made available to participating students at any time during the study. Also note that the highest possible score is figured by multiplying the number of possible answers by the point value.

Table 2.
Changes in Concept Mapping Scores

Average Number of Answers

Category	Possible Answers	Pre	Post
Valid Relationships	55	0	0
(Conceptual) Hierarchy	13	2.81	9.20
Cross Links	14	0	11.20
Examples	30	7.47	10.35

Open-ended team interviews were conducted in order to establish a nominal group. The purpose of the interview was to probe how concept mapping contributed to interactivity, and/or student learning within the web-based distance education test module. The interview transcriptions were coded to document themes and patterns in the participants perceptions. The following themes and patterns emerged:

- 50% of the interviewed students indicated that they felt student-to-student interactions had increased;
- 100% of the interviewed students indicated that they felt student-to-content interactions had increased; and
- 100% of the the interviewed students indicated that they felt that various components within the print-based content took on the role of teacher

Although only three of the six participants asserted that concept mapping was a useful learning tool that enhanced their learning experience, all of the participants indicated that concept mapping required them to re-think their ideas about poultry physiology concepts All of the participants indicated that they believe that the differences in their pre- and post-content knowledge concept mapping performance was due to lack of knowledge concerning poultry physiology during pre-mapping. Further, all of the participants asserted that if they were given the opportunity to re-do their post maps they would add more details.

This study can be described as a single case study. The results of one case study may be insightful, but the results of a series of case studies which examine the same topic would be more conclusive. Further, the total number of students who participated in the concept mapping was 21 and in interviews six; increasing the number of participants by replicating this study would enable me to generalize my findings with greater certainty. Development of another series of courseware modules is underway and will provide the opportunity for additional case studies.

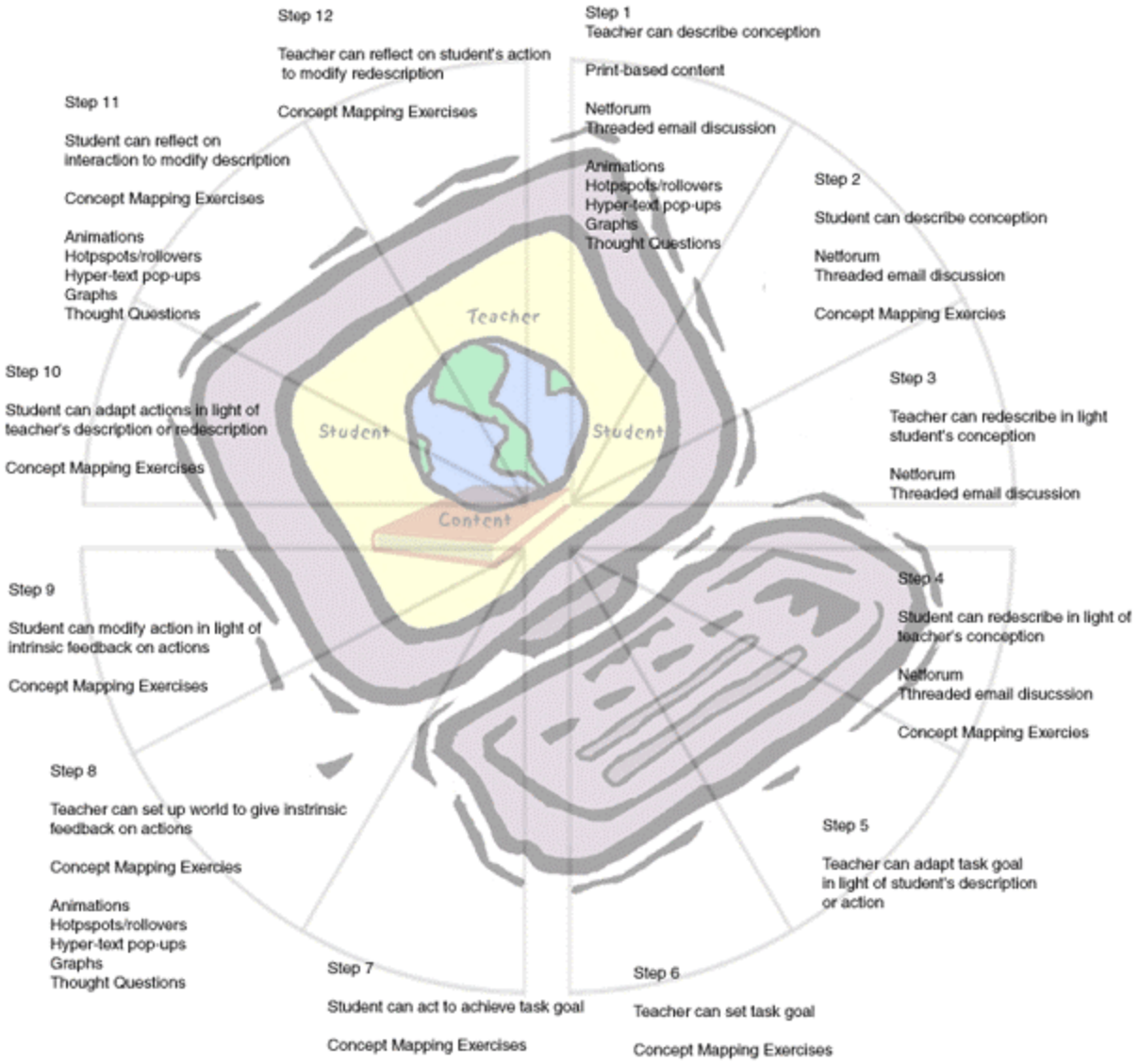
The Model

To replicate the UAF web-based learning environment teachers should consider constructing a web-based learning environment similar to the UAF courseware as described and illustrated below:

The UAF learning environments fulfilled the proposed definition of adequate dialogue by presenting the content for each course as described below and by providing concept mapping exercises. The content for each course was constructed within an interactive textbook or print-based metaphor in a structured manner according to Moore's theory of "transactional distance" through: 1) thoughtful articulation of **instructional goals** 2) the use of **objectives** within each content module, 3) a

thorough treatment of the subject (that also employed the use of thought questions for reflection), 4) concept mapping exercises, and 5) the visualization of key concepts. The visualization of key concepts included animations, hotspots/rollovers, animated hotspots/rollovers, hypertext pop-ups, and graphs.

The following illustration roughly shows the elements that made up the UAF web-based learning environments. The computer in this graphic is intended to symbolize that the courses were web-based. The graphic on the monitor illustrates Moore's theory of transactional distance and the book emphasizes that the content was purposefully structured around a print-based format. The pie chart in the back ground re-lists each step of Laurillard's conversational framework and shows how the various components fulfilled these steps. Please note that concept mapping was the only element that supplied a high level of interactivity.



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