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Dedicated to

Late Professor Amlan Dutta
The Humanist of the era

and

Late Professor Arati Sen
Educationist

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Designing Effective Online Courses with First Principles of Instruction

Theodore W. Frick, Joyce Hwee Ling Koh and Rajat Chadha

Online courses are becoming a popular mode of learning. The proliferation of Web 2.0 tools present exciting possibilities to change paradigms of education, especially for students who do not perform well in traditional face-to-face courses (Christensen, Johnson & Horn, 2008).

These developments raise the following critical questions:

Is there one best theory to guide the design of online instruction?

Is there one best tool for online instruction?

This chapter addresses these questions by proposing that effective online instruction is not attained through the use of one best instructional theory or tool. It can, however, be achieved by embodying a set of fundamental principles for online instruction. These "*First Principles of Instruction*" (Merrill, 2002, 2007a) are applicable regardless of the medium of instruction. In addition to discussing examples of how the *First Principles of Instruction* can be applied to both online and face-to-face instruction, this chapter also presents the Teaching and Learning Quality (TALQ) survey, an instrument designed to evaluate training courses according to these *First Principles*.

Different Perspectives of Effective Instruction

Developments in the field of learning psychology have influenced how we design instruction. Between the 1950s and 1970s, behaviorism defined learning as a behavior that could be shaped by environmental stimuli. In the 1980's, cognitivist views of learning shifted our focus from environmental stimuli to learner cognition, while the 1990's saw the advent of constructivist theories that advocate learner responsibility for constructing their own learning. What does each of these perspectives recommend?

Behaviorism

B.F. Skinner's model of operant conditioning was a behaviorist theory that had immense impact on education. Operant conditioning postulated that voluntary behavior could be strengthened or weakened by controlling the environmental antecedents and consequences following the behavior (Driscoll, 2000). A central idea in operant conditioning advocates that complex behavior could be broken down into simpler components and then learned incrementally through the process of shaping (Burton, Moore & Magliaro, 1996; Skinner, 1996). When applied to instruction, reinforcers and inhibitors of learning behaviors could be designed and executed as a series of stimuli to shape desired learning outcomes.

Operant conditioning influenced the development of an instructional methodology called Programmed Instruction. This was a series of self-paced learning materials where learning content were presented to students in short segments. Students answered questions after completing a segment, and were given immediate feedback. They would be allowed to proceed to new material if their answers were correct, but redirected to remedial explanations for wrong answers (Heinich, Molenda & Smaldino, 1999; Reiser, 2001).

Cognitivism

Behaviourist theories were concerned about the relationship between environmental stimuli and learner behaviors. Learner cognition was considered as a 'black box' that need not be understood (Driscoll, 2000). Cognitive psychologists argue against the assumption that learners are passive recipients of environmental stimuli. Rather, students' cognition and thinking impact how they learn. In particular, cognitive psychology theories such as *Schema Theory* and *Network Models* propose that learners have a system of knowledge organization, either as schemas or as a network of nodes and links (Bruning, Schraw, Norby & Ronning, 2004). Learning occurs when knowledge is assimilated, encoded, and can be effectively retrieved from long-term memory.

Cognitivist theories guided the development of several instructional theories that address the cognitive processes involved in learning. One example is Gagné's nine events of instruction, which are comprised of activities that instructors can use to stimulate internal cognitive processes such as attention, retrieval and reinforcement (Gagné, Briggs & Wager, 1988). Examples of these events are gaining the attention of students, stimulating recall of prerequisite learning and providing feedback about performance correctness. While Gagné's theory dealt with an overall view of the instructional process, other theories addressed complex cognitive operations that involved algorithms or heuristics. An example may be the

Algo-heuristic Theory of Instruction (Landa, 1983), which proposed that unobservable cognitive processes could be analyzed into a 'level of elementariness' that they could be understood and performed in a standardized way by a student without error. These processes could be combined to derive algorithms and heuristics for problem-solving.

Constructivism

The 1990's saw a rising concern that the education system was too focused on rote instruction with students as passive recipients (Airasian & Walsh, 1997; Perkins, 1991). Constructivist views of learning propose that reality is in the mind of the learner, and learning is a process whereby learners construct meaning from the ways in which they perceive and interpret their experiences (Jonassen, 1991).

Several instructional theories sought to describe learning environments that support and mediate active learning of students. Grabinger (1996) proposed that rich environments for active learning (REALs) should use realistic problems and authentic assessment, promote student responsibility and initiative for learning, encourage cooperative learning, and provide generative learning activities that promote argumentation and reflection. These basic principles were also embodied by Hannafin, Land and Oliver (1999). Their conception of *Open Learning* Environment included providing students with concrete experiences through problem contexts, and stimulating self-directed learning by supporting the process of problem conceptualization, metacognition, and problem-solving with information tools. Jonassen (1999) also described a theory for desiging constructivist environments that provide authentic problems, learner selectable information and tools. However, his model emphasizes the use of related cases and worked examples as cognitive scaffolding, and supporting learning through modelling, and coaching.

How to Design Effective Online Learning?

With such a proliferation of instructional models, one may wonder if there is one best way to approach the design of online instruction that could increasingly involve the use of Web 2.0 tools. In an online environment, learning occurs within what Garrison, Anderson, and Archer (2000) termed a '*community of inquiry*' where teachers and students interact to construct knowledge. Effective instruction occurs when the community attains 'deep learning' (i.e. focused on meaning and understanding), as opposed to 'surface learning' (i.e. focused on information recall) (Scouller, 1998). Deep learning has also been understood as cognitive presence or critical thinking (Garrison et al., 2000).

Salmon (2004) developed a five-step model for effective e-learning moderation. It is primarily focused on managing student access, ownership, and knowledge construction as they learn through the online platform. This model provides a good start to the effective management of online learning experiences. But, there are few other instructional theories related to online or Web 2.0 platforms. What principles can be used for effective online instruction? Can principles from behaviorist, cognitivist, and constructivist perspectives apply?

The First Principles of Instruction

The *First Principles of Instruction* were developed by David Merrill in an attempt to identify the common features underlying various instructional theories (Merrill, 2002, 2007a, 2007b). It describes the fundamental principles of effective instruction, and provides a unifying view of different instructional perspectives. The *First Principles* were derived through theoretical analysis of major instructional theories (Merrill, 2002). The five fundamental principles described in Merrill (2002) and Merrill (2007a) are summarized in the following section:

1. Task-centered principle

Learning is promoted when learners engage in tasks from the real-world, are taught the whole task, and learn tasks in progressive order of complexity.

The task-centered principle first proposes that instruction should be anchored upon real-world problems or tasks. This emphasis on authentic learning contexts has been advocated in various instructional theories that have been influenced by constructivist perspectives. Problem-based learning (PBL), for example, is a method where students learn knowledge and skills through the process of problem-solving (Albanese & Mitchell, 1993). Students engaging in PBL are not taught basic skills but seek and learn appropriate knowledge as they engage in problem-solving. Merrill (2007a) emphasized the *First Principles* to have a 'problem-centered approach' (Merrill, 2002; p. 45), but advocates teaching learners directly how to solve problems. The *First Principles* also recommend a *whole task* approach to instruction (Merrill 2007b; Van Merriënboer, Clark & de Croock, 2002), as opposed to teaching tasks as distinct parts. Learning how to solve parts of a problem did not imply that learners could synthesize their knowledge to perform the task effectively. A *whole task* approach ensures that the knowledge of individual task-components are integrated towards problem-solving. Tasks should also be taught in progressive levels from simple to complex. This corresponds to the recommendations of the Elaboration Theory (Reigeluth, 1999) and the 4C/ID model (van Merriënboer, 1997).

2. Activation principle

Learning is promoted when learners are prompted to share or demonstrate prior knowledge and experiences; and provided with a structure to organize new knowledge

The Activation principle is consistent with the postulations of cognitivist theories. When students share or demonstrate prior knowledge, their existing schemas and memory networks are instantiated, which helps them to assimilate new knowledge with their pre-existing structures of understanding. Bransford, Brown and Cocking (2000) found that students are better able to master new concepts when teachers engaged their initial understanding at the onset of teaching. Network Theory also proposes that information is retrieved through the process of spreading activation along one's hierarchical knowledge network (Bruning et al., 2004). Learners with more extensive networks of knowledge are capable to search and retrieve information more efficiently. If learners have limited prior knowledge or experience with the content, they need to be provided with structures of knowledge to help them form schemas of what they will be learning. Examples of such structures are advanced organizers (Ausubel, 1963). They help students develop cognitive structures to organize new content they are learning.

3. Demonstration principle

Learning is promoted when the information and portrayals of demonstrations are consistent.

Merrill (2007a) described five types of component skills that could be involved in task mastery: information-about (facts related to the task), parts-of (parts of a task entity), kinds-of (different classes of a task), how-to (procedures and steps of a task), and what-happens (conditions, and consequences of actions). Successful demonstrations occur when there is consistency between the information and portrayals of a component skill (Gagné, 1985; Merrill, 1994). For example, explaining and demonstrating the steps of a task will teach learners "how-to", but not "what-happens"; which is more suitably taught by providing information and enactments with scenarios and case studies. Effective instruction of task performance occurs when information and portrayals are consistent with the component skill. Without this consistency, learners will be left to learn task performance through their own discovery.

4. Application principle

Learning is promoted when students apply what they learned through a varied sequence of tasks that is consistent with its task component. Application needs to be supported with corrective feedback, and coaching needs to be gradually withdrawn to facilitate independent performance.

Practice and feedback have been prescribed in various instructional theories (Bereiter & Engelmann, 1966; Gagné et al., 1988). A particularly successful behaviorist model is Direct Instruction where students are taught through systematic presentation of learning content, guided practice, feedback, and independent practice. It was found to have positive impact on student achievement, engagement and affect (Magliaro, Lockee, & Burton, 2005). In the Application principle, Merrill (2007a) recommended that effective practice occurs when learners practice solving a series of tasks or problems of varying complexity. This ensures that learners are being exposed to the range of task complexities they are required to master. It also requires that practice be consistent with the task component that is being mastered. For example, asking learners multiple choice questions about the steps of a task will help them review their knowledge of 'information-about', but does not provide practice that facilitates mastery of 'how-to'. Therefore, consistency between information, portrayals, and applications of task components is also required for effective instruction.

The Application principle further emphasizes that feedback should be corrective—i.e. where errors are pinpointed with suggestions for correction. It is more effective than merely telling learners if they are right or wrong. This corresponds with the constructivist theory of minimalism, where learners are taught to recognize and correct their errors while working on authentic problems (Carroll, 1990). Another important aspect of the Application principle is the need to foster mastery by diminishing coaching gradually. This is synonymous with the idea of scaffolding (Wood, Bruner, & Ross, 1976), where experts help novices to master specific tasks they cannot originally perform without assistance—i.e., tasks which are in the learner's zone of proximal development (cf., Vygotsky, 1978). This is done by controlling the level of support and assistance until novices are able to master and perform the entire task independently (Puntambekar & Hubscher, 2005).

5. Integration principle

Learning is promoted when learners explore how their newly gained knowledge and skills can be personally useful.

Constructivist views of learning propose that humans are active agents, who desire to make sense of their world (Perkins, 1991). The Integration principle proposes that effective instruction occurs when learners are able to find personal meaning in what they learned. One way of helping learners integrate knowledge is through personal reflection. Learners should be challenged to explore personal applications beyond what was learned in class. Peer discussions and critique can also be used to stimulate the process of integration. Social constructivists such as

Vygotsky (1978) postulated that learning occurs through social interaction. Several instructional methods, such as reciprocal teaching (Palinscar & Brown, 1984) and the Learning Together Model (Heinich et al., 1997), are examples of instructional methods that use social experiences to enhance learning.

Research on First Principles of Instruction

Thomson/NETg conducted an experimental study in which they investigated the relationship between all five *First Principles of Instruction* and student learning achievement (Thomson, 2002). Instructional designers from NETg applied *First Principles of Instruction* to revise an existing e-learning Excel course to a new scenario-based course. In the revised course, Excel commands were taught in the context of scenarios similar to real-world problems that included five spreadsheet problems.

NETg recruited 128 volunteer participants from among their customers. Participants were divided into three groups: a scenario-based group ($n = 49$), the existing e-learning group ($n = 49$), and a control group ($n = 30$) which did not receive any instruction.

The existing e-learning course illustrated Excel commands and operations in a typical didactic approach. This part of the existing e-learning course was also accessible to the scenario-based course group. The difference in the scenario-based course group was that Excel commands were taught in context of five authentic problems. This part of the course was designed following the *First Principles of Instruction.*

Following instruction, learners took a post-test on three Excel tasks. Differences in group means on the post-test were statistically significant ($p < 0.001$). In the scenario-based course that used *First Principles of Instruction* the group mean was 89 per cent, whereas the group mean for the existing instruction was 68 per cent, and the control group scored 34 per cent on average. Furthermore, the time required by the scenario-based course group to complete the post-test was considerably less than that of the existing e-learning based course group (29 vs. 49 minutes, $p < 0.001$).

In a subsequent descriptive-correlational study, Frick, Chadha, Watson, Yang and Green (2008) collected data from 140 students enrolled in 89 different courses at several U.S. universities. They found that student ratings of instructor use of *First Principles of Instruction* were correlated significantly ($p < 0.0005$) with student self-reported academic learning time ($r = 0.682$), learning progress ($r = 0.823$), mastery of course objectives ($r = 0.341$), satisfaction with the course ($r = 0.830$), and student ratings of overall instructor and course quality ($r = 0.867$).

In a somewhat larger study, Frick, Chadha, Watson and Wang (2010) collected data from 193 students enrolled in 111 different courses at

multiple postsecondary institutions. Similarly, they reported very high Spearman correlation coefficients between student ratings of instructor use of *First Principles of Instruction* and student self-reported academic learning time ($r = 0.670$), learning progress ($r = 0.833$), mastery of course objectives ($r = 0.344$), satisfaction with the course ($r = 0.850$), and student ratings of overall instructor and course quality ($r = 0.890$). All correlations were statistically significant at $p < 0.0005$.

In the most recent study of 464 students enrolled in 12 different courses at a large Midwestern U.S. university, Frick, Chadha, Watson and Zlatkovska (2009) reported similar highly significant correlation coefficients ($p < 0.0005$) between the student ratings of instructor use of *First Principles of Instruction* and student self-reported academic learning time ($r = 0.583$), learning progress ($r = 0.725$), satisfaction with the course ($r = 0.778$), and student ratings of overall instructor and course quality ($r = 0.774$).

In this study, *instructors* also rated their students according to their mastery of course objectives. These ratings were based on student performance in those instructors' classes and were typically based on test scores, projects, papers, etc. Frick et al. (2009) found that if students agreed that their instructors used *First Principles of Instruction* and they also agreed that they experienced academic learning time (ALT), those students were about 5 times more likely to be independently rated by their instructors as having achieved a *high level of mastery* of course objectives. Perhaps even more significant was the finding that when students did not agree that their instructors used *First Principles* and also did not agree that they experienced ALT, they were about 26 times more likely to be independently rated at a *low level of mastery* by their instructors.

Two of the studies conducted by Frick et al. (2008; 2010) included students from online and face-to-face classes. Approximately one-third of the respondents in each study rated courses that they had taken online, compared with two-thirds who had rated face-to-face courses. There were no significant differences (ANOVAs) between online and face-to-face respondent groups on student ratings of instructor use of *First Principles of Instruction,* student ALT, satisfaction, learning progress, or ratings of overall quality. Nor were there any significant associations (Chi-Squares) between course setting (online verses. face-to-face classes) and other demographics such as gender, year in school, and course grade. In short, course setting had no statistically significant association with other variables measured in those two studies.

In the three descriptive-correlational studies conducted by Frick et al., items on the various scales were randomly mixed on the survey

instruments so that students knew neither what the scales were nor which items were associated with each scale. Each scale consisted of 2 to 5 items, and internal consistency reliabilities of these scales were reported to be generally high (Cronbach alpha coefficients). The survey instrument is referred to as the Teaching and Learning Quality (TALQ) scales.

Chadha (2009) has further studied these scales by investigating agreement of ratings among students within a class and the dependability of these TALQ measures. Based on his findings, he recommends the course evaluation items listed in Table 3.1. Students respond to each item on a Likert scale (Strongly Agree, Agree, Undecided, Disagree, Strongly Disagree). These items should ideally be randomly ordered within the overall course evaluation instrument so that students should not be aware of the scales being used.

Items from each scale (e.g., academic learning time, activation) are then averaged to form a scale score (cf. Frick, et al. 2008). Note that several items are worded negatively as a check on whether students are reading the items carefully, and should be reverse-scored before combining into the respective TALQ scale. If reverse-scoring is not practical, then one should avoid the negatively worded items, or modify the wording to make them positive.

TABLE 3.1: Recommended TALQ scale items

Scale	*Items*	*Notes/Comments*
Global Instructor and Course Quality Scale	• Overall, I would rate the quality of this course as outstanding. • Overall, I would rate this instructor as outstanding. • Overall, I would recommend this instructor to others	Use all 3 items for best scale reliability.
Student Satisfaction Scale	• I am very satisfied with how my instructor taught this class. • I am dissatisfied with this course. • This course was a waste of time and money. • I am very satisfied with this course.	Use 2 or 3 of the original 4 items. Note that the middle two items are stated negatively and would need to be reversed-scored before combining into a scale.
Academic Learning Time Scale	• I did not do very well on most of the tasks in this course, according to my instructor's judgment of the quality of my work.	Use all 4 items. The 1st item must be reverse-scored before combining with the remaining items to form a scale score. Note that the

Scale	*Items*	*Notes/Comments*
	• I put a great deal of effort into this course. • I frequently did very good work on projects, assignments, problems and/or learning activities for this course. • I spent a lot of time doing tasks, projects and/or assignments.	2nd and 4th items measure student engagement separately from student success in course tasks on the 1st and 3rd items.
Learning Progress Scale	• Compared to what I knew before I took this course, I learned a lot. • I learned a lot in this course. • Looking back to when this course began, I have made a big improvement in my skills and knowledge in this subject. • I learned very little in this course. • I did not learn much as a result of taking this course.	Use 2 of these items. Note that if the last 2 items are chosen, they must be reverse-scored before combining into a scale.
Authentic Problems Scale	• I was expected to perform a series of increasingly complex authentic problems in this course. • I was expected to solve authentic problems or to complete authentic tasks in this course. • In this course I was expected to solve a variety of authentic problems that were organized from simple to complex.	Use all 3 items from this scale.
Activation Scale	• I engaged in experiences that subsequently helped me learn ideas or skills that were new and unfamiliar to me. • In this course I was able to recall, describe or apply my past experience so that I could connect it to what I was expected to learn. • My instructor provided a learning structure that helped	Use at least 3 items on this scale. Note that if the last item is used it must be reverse-scored before combining with others to form this scale.

Scale	*Items*	*Notes/Comments*
	me to mentally organize new knowledge and skills. • In this course I was able to connect my past experience to new ideas and skills I was learning. • In this course I was not able to draw upon my past experience nor relate it to new things I was learning.	
Demonstration Scale	• My instructor demonstrated skills I was expected to learn in this course. • Media used in this course (texts, illustrations, graphics, audio, video, computers) were helpful in learning. • My instructor gave examples and counter-examples of concepts that I was expected to learn. • My instructor did not demonstrate skills I was expected to learn. • My instructor provided alternative ways of understanding the same ideas or skills.	Use all 5 items of this scale. Note that the 4th item needs to be reverse-scored before combining with others to form this scale.
Application Scale	• My instructor detected and corrected errors I was making when solving problems, doing learning tasks or completing assignments. • I had opportunities to practice or try out what I learned in this course. • My instructor gave me feedback on what I was trying to learn.	Use all 3 items.
Integration Scale	• I had opportunities in this course to explore how I could personally use what I have learned. • I see how I can apply what I	Use any 3 items.

Scale	*Items*	*Notes/Comments*
	learned in this course to real life situations. • I was able to publicly demonstrate to others what I learned in this course. • In this course I was able to reflect on, discuss with others, and defend what I learned.	

An Example of Application of *First Principles* to a Graduate-Level Course

Next, we describe an example of a course, which has been redesigned around *First Principles of Instruction*, R690: Application of Research Methods to IST Issues. This course is intended for Ph.D. students in Instructional Systems Technology (IST), to be taken early in their program. *The 2008 syllabus to this course is provided online at*:

https://www.indiana.edu/~istr690/frick08fall/index.html (Frick, 2008a).

The goal of R690 is to help graduate students to "learn disciplined inquiry in IST through first-hand experience—i.e. by doing representative research tasks and critiquing research done by others. The objectives of this course are to:

1. Conduct interviews for need-assessment (qualitative method).
2. Do content analyses (qualitative method).
3. Conduct usability evaluations (qualitative and quantitative methods, problem diagnoses).
4. Write a report describing needs assessment, results, usability evaluation, results, and recommendations (for client and instructor).
5. Analyze existing survey data with SPSS (quantitative methods, tool skills).
6. Critique research reports done by others." (Frick, 2008a, n.p.)

The reader should note that the objectives of this class are described as *tasks* that students are expected to do. Through these tasks, students are expected to learn about different kinds of research methods and important criteria for judging the adequacy of research. While understanding is important, it is connected to these tasks. These tasks determine the structure of the course instead of topics such as qualitative research methods in IST, quantitative methods, content analysis, statistical package for social sciences (SPSS), chi-square, *t*-tests, etc. The instructor

has identified specific resources that students are expected to read on a weekly basis outside of class. Students are expected to apply knowledge from these resources to tasks that they are expected to do.

The following elaborates the course's use of *First Principles of Instruction*:

Students in R690 are expected to conduct *Authentic Tasks*—typical of research in IST—, which are organized from simple to complex. The first authentic whole task students are expected to do is to conduct disciplined inquiry for a need-assessment and analysis. In this task students as a whole class led by the instructor create interview questions related to the area of need. For example, in 2007-2008, the IST Department was redesigning its website and wanted to know what the target audience expected to find there and what they would want to do on the website. In this case, the IST Department was the client.[1]

Next R690 students are expected to conduct interviews with members of the target audience in which the questions are asked and interviewee responses are further probed. Students work in pairs so that one is asking the questions and follow-ups while the other takes detailed notes on the respondent's answers. Students used to conduct interviews with at least two real interviewees each. Each student then writes up the results of his or her two interviews as a report. Thus, this is a whole task in disciplined inquiry, and it is authentic since the results are used by a client who needs such a needs assessment to be performed. It is a meaningful, real-world task.

These interview reports are further analyzed in class by caryingout a content analysis in an activity led by the instructor. Individual responses to each interview question are cut and pasted onto individual 3x5 cards. Students discuss their findings as they do this activity sitting around a table. The instructor then leads a card-sort activity—similar to the classic game, *Concentration*—in which cards containing commonalities are grouped. Students take turns reading the responses on their cards and then the group quickly tries to identify which pile it belongs to (via rapid free association). The piles 'emerge' as common themes or patterns in the interviewee responses.

The second authentic task that students are expected to do is to conduct a usability test. They must first create usability tasks based on the results of the prior needs assessment (e.g., that the target audience would do on a website that is being evaluated). These usability tasks are formed during a class activity in which the results of the previous content analysis (the various piles from the card sort activity) are utilized. Then students must design the usability study and carry it out with at least two members of the target audience. Students again work in pairs so that one can administer the test while the other takes detailed notes on an observation form.

Students are then expected to write a team report in which the results are combined which identifies major problems with the product and makes recommendations for possible improvements to minimize the problems observed. This, too, is a whole task that is authentic.

The needs assessment and usability evaluation tasks require mostly qualitative methods.

The third task in this course requires students to use quantitative methods for analysis of findings in a research study that was previously completed by a former IST Ph.D. student in his or her dissertation. R690 students are provided with a number of research questions that require use of descriptive and inferential statistics for analysis via SPSS; and they are expected to each independently write a report that provides the results of the analysis and the conclusions drawn from the results. Each student is given a subset of the real data that had been previously collected, so he or she will not necessarily obtain the exactly the same results as found in the original study.

The final task in this course is to identify and critically evaluate a published research study in an area of interest to each student. The student is expected to critique the study as one would do if reviewing it for a journal editor, applying criteria that are typically required by research journals for such reviews. Each student critique is written as a report that describes the research study, applies relevant criteria to the study, and then draws conclusions based on the application of the criteria. Thus, this R690 course is structured around these four authentic, whole tasks that are arranged in increasing complexity.

In this R690 course the *Activation Principle* is exemplified in the following ways: For example, in the very first class student teams conduct mini-research projects in which they are given a specific research task, carry it out, and report their findings to the whole class. This is to give the students a common experience that they can connect with later activities in the course. Each mini-research project exemplifies different kinds of knowledge outcomes from disciplined inquiry. As another example of activation, when students are getting ready to do the SPSS data analysis tasks, the original author of the research study makes a presentation to the class. Students also read the research report as a further means of activation so that they will be able to connect the SPSS tasks they are expected to do with this completed research study. As a further kind of activation, the instructor provides a conceptual structure (advance organizer) for types of knowledge that results from research, so that students can connect findings in research reports they read with this conceptual model.

In the R690 class, an example of the *Demonstration Principle* is a video that students watch which illustrates how to conduct a usability

test. The instructor also models how to do a content analysis, which is done as a group activity in which the results from student interviews are subjected to a card-sorting procedure in order to identify categories and trends. He further demonstrates the use of SPSS and various descriptive and inferential statistical functions for carrying out the data analysis tasks. The instructor not only shows them how to use SPSS itself, but also models how to interpret the results based on the data analyzed. When students are expected to conduct research critiques, the instructor models the application of evaluation criteria repeatedly in classes in which research studies are critiqued through whole-class discussion. Students are also expected to read critique reports that past students have written, which serve as further models of critiques.

For the *Application Principle*, students are expected to conduct interviews for the needs assessment and to write a report. The instructor provides feedback via e-mail when their reports are submitted electronically and when he grades them. For the usability evaluation, students often initially practice a usability test with the instructor acting as the "subject" so that he can provide feedback on how well they conducted the usability test. Students then perform the usability tests with real subjects. In the SPSS activity students do the SPSS analysis of their own individual (and unique) data sets in which they answer a series of research questions. The instructor provides feedback two ways:

1. After students have written their reports, he shows them a model report he has written so that they can compare their results with his results.
2. He also provides individual written feedback when he grades their reports.

Students practice doing research critiques during numerous class discussions when research studies are jointly critiqued, and the instructor provides feedback on their critical thinking in class (as well as models critical thinking). Students also apply what they have learned when they do their individual critiques and write them up. The instructor provides detailed feedback when he grades their critiques. These are all examples of the *Application Principle.*

The *Integration Principle* is illustrated in this class in a number of ways. In the very first class, student teams make presentations to the rest of the class on the findings from their mini-research projects. In the part of the course where they are doing the critiques, each student is assigned a time slot in a class session in which he or she is expected to present a summary of the study being critiqued via a short PowerPoint presentation to the class. Everyone in the class is expected to have read the study prior

to class. The student then leads the discussion of the study, while the instructor also contributes additional insights and criticisms of the study. Students are also expected to integrate what they learn in the R690 class as they participate in external research groups led by faculty in the department (these groups are conducting research studies, mentored by those faculty members).

In summary, this R690 course has been designed on the basis of *First Principles of Instruction.* This course had been designed originally around Problem-Based Learning (PBL) and taught this way for about 12 years. R690 was redesigned in 2006 with *First Principles of Instruction* in mind. Although the R690 course has historically received very good ratings in student course evaluations, ratings have been even higher since the redesign.

Considerations for Conversion of R690 to an Online Course

Next, the authors provide an example of what it would take to convert an existing face-to-face course to an online course that utilizes *First Principles of Instruction.* Since R690 is already designed around *First Principles*, the challenge is to determine ways in which current face-to-face activities can be accomplished in an online learning environment. Planning for this conversion is described next.

First, the R690 class already has a website that is online (see Frick, 2008a). The first author has previously created a template in Adobe Dreamweaver, which is easy to use and update. He either uses Dreamweaver or Adobe Contribute to edit the web pages associated with the R690 course which uses the course template[2]. This course website includes the syllabus, the course schedule, a list of resources (with restricted access), and links to Google Groups (a free online tool) for document sharing and asynchronous discussion among students when working on tasks. The distance version of R690 is expected to use a similar course website.

Indiana University currently provides a content management system called Oncourse. Two aspects of Oncourse are used in R690: the drop box and the grade book. The drop box is where each student can electronically submit a deliverable, such as the report on the results of the interviews she or he did or his or her research critique. Each Oncourse drop box is private in that only the student and his or her instructor can view it. The Oncourse grade book provides a student roster and allows the instructor to enter a list of assignments to be graded in the class. Thus, the instructor can easily award points or letter grades to each item for each student and can provide feedback in an adjacent text box. The grade book is also private in that a student can only see his or her own grades and instructor feedback.

Google Groups is planned for asynchronous discussion because of the excellent way it is integrated with a wiki (called Pages in Google Groups), a document sharing area (called Files), and e-mail among students in the group.

Indiana University also provides Adobe Acrobat Connect for use by instructors and students. Acrobat Connect (formerly Macromedia Breeze Meeting) allows for synchronous interaction with voice and video via each participant's webcam. Another extremely important feature is that the instructor (and also students) can share their computer screens—thus everyone in the group can see that user's computer screen, which could be displaying a PowerPoint presentation, a word processing document, a web page, etc. Group meetings in Acrobat can also be recorded for archival purposes, so those who cannot attend in real-time can view the meeting at a later time. Acrobat Connect also provides a back channel for Internet chat to occur, which is also useful if there are audio problems, or if students have comments or questions and do not want to interrupt the ongoing video demonstration or audio discussion.

In R690, a class presentation or demonstration could be done live in Acrobat Connect and recorded. Anecdotally, the instructor has found it more convenient to make movies or podcasts with TechSmith's Camtasia, since the quality of audio and video is better and these can be easily edited and combined[3]. For example, a movie demonstrating the SPSS data analysis tasks could be made. During the live demonstration in class, the instructor could run Camtasia to capture his voice and the computer displays. Then the captured audio and video could be edited and put online. This could then be viewed online by students not only in the face-to-face class, but also in the distance version. In summary, current class sessions in R690 where there is an instructor presentation or demonstration can be recorded as podcasts or movies.

For R690 class activities in which students carry out a task with instructor coaching, a somewhat different approach will be needed for the online version. For example, the R690 card-sorting activity that is done as a group for content analysis of interview results would not lend itself to capture by Camtasia. Here it would make sense to have someone record this face-to-face class activity with a digital camcorder when this card-sort activity is undertaken. This way, online students could watch it (*Demonstration Principle*).

However, students would not be able to participate actively in the card-sort themselves (*Application Principle*) when just watching the online video. This card-sorting activity might be conducted synchronously online by a combination of Acrobat Connect and Microsoft Word. For example, the class could be participating synchronously in Connect, while the instructor is sharing his computer screen. On his computer screen could

be a Word document. In Word, text boxes could be created for each pile as they emerge. Students could take turns reading to the group an item on their 3 × 5 card (or paste it into the chat line, so everyone can see the item in chat). Everyone would look at the Word document and then decide which pile (text box) it should go in.

If this card-sorting activity could not be done synchronously, then it could be done asynchronously via Google Docs. Google Docs allows a group to share and edit together a single document online. Some protocol would need to be developed so that students could add their 3 × 5 cards to various piles or stacks. Alternatively, each student could get all the 3 × 5 'cards' from everyone and do the card-sorting activity by himself or herself. Then each student would post a document (e.g., in Google Groups) that would show the results of his or her card-sort. Students could then compare their results by examining each other's documents and discuss the similarities and differences asynchronously in the Discussions area of Google Groups.

For the research critique classes, each student would post (in PDF format) the research article to be discussed in the Files section of Google Groups, or just attach it to a Discussions topic that is viewable by the class, or e-mail it to the instructor who would then in turn upload it to the course website and make a hyperlink to it. Students in the class would be expected to read the article before the critique session would begin.

Since each student is expected to make a presentation and lead the critique, that student could make a PowerPoint presentation ahead of time and then make the presentation in Acrobat Connect by sharing his computer screen. Alternatively, the student could record his or her voice over the PowerPoint presentation and capture it with Camtasia. The recording could then be uploaded to the course website so everyone in the class could view it.

The in-class critique and discussion of each research report is an important activity that normally is done in the last third of the R690 course. This could be accomplished via synchronous discussion in Acrobat Connect. Alternatively, the Discussions feature of Google Groups could be utilized so that an asynchronous written discussion of that research article could occur. Some kind of structure and protocol for participation in the critique session would need to be created. The instructor would need to participate regularly in the discussion board in order to provide important feedback to students with respect to their application of criteria used in critiques.

In summary, the above description should give the reader an idea of how an existing face-to-face course that has been designed with *First Principles of Instruction* could be converted to an online course. Next, an existing online course that utilizes *First Principles* is described.

An Existing Online Course Designed around *First Principles of Instruction*

The first author has also designed and taught an online course, R547: Computer-Mediated Learning. See the syllabus (Figure 3.1).

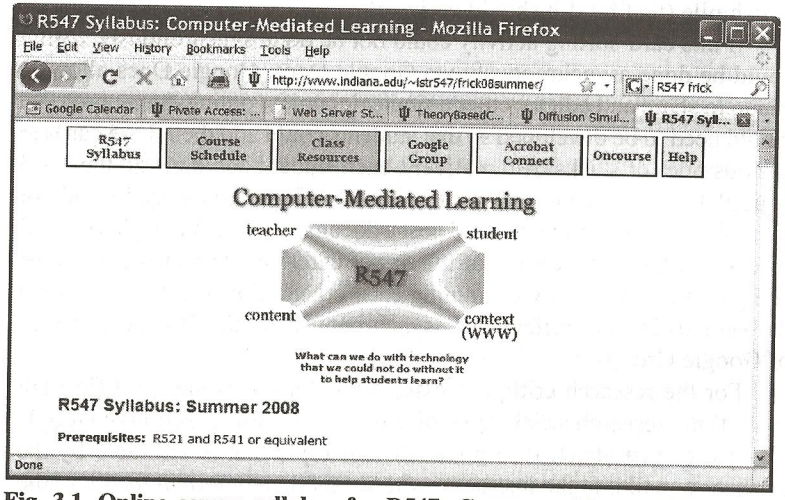

Fig. 3.1. Online course syllabus for R547: Computer-Mediated Learning https://www.indiana.edu/~istr547/frick08summer/index.html (Frick, 2008b)

The primary goal of R547 is for students to develop an e-learning product themselves that is a real-world project, i.e., it will be used online by others for purposes of learning. An example of such a product is an e-learning product made by a student in 2006: http://mentor.ucs.indiana.edu/~frick/r547/2006/creditcards/menu.htm (Frick, 2006). The R547 distance student was working for a company that counselled their clients on how to understand statements from creditors (e.g., a credit card billing statement a client has received). The e-learning product s/he developed in R547 was then used by her company as part of training for the counsellors who worked with clients.

The student e-learning products in R547 are expected to incorporate *First Principles of Instruction*. This requirement can be understood by viewing the syllabus grading criteria at https://www.indiana.edu/~istr547/frick08summer/#grading (Frick, 2008c).

Sequencing of authentic tasks is accomplished in R547 by two parallel streams. One stream focuses on how to technically put instruction and resources on the web, without worry about the specific content. A second parallel stream has to do with design and development of the learning.

In the technical stream, it begins with the simplest form of Web publishing. Students are expected to convert an existing document that

is in Word (e.g., his or her résumé) to PDF format and then to upload it to his or her website. The task is completed when the student sends e-mail to the instructor with a hyperlink to the PDF file, and also adds the hyperlink to the wiki page (in Google Pages) for posting his or her course deliverables. This is the epitome of Web publishing, put a file on one's website and then create a hyperlink that points to it. A more complex task is done next. Students are expected to create a Dreamweaver template for their e-learning website and to build a navigational structure for moving from one part of the site to another. The web pages just have placeholder content or dummy content. The third task is to create a style sheet in CSS and use it as part of their Dreamweaver template. A bonus activity requires students to create a folder with restricted access as part of their website.

In the design stream, students are first expected to determine the objectives of their e-learning product and how they are going to assess student achievement or mastery or those objectives. Students are then expected to create a rapid *paper* prototype of their e-learning product (or the parts that can be done online) that shows evidence of utilization of *First Principles of Instruction.*

The two streams then merge as the student is expected to create a rapid *computer* prototype of his or her e-learning product. The student is subsequently expected to conduct formative evaluation and usability tests of the e-learning product with at least three members of the target audience. The R547 student also evaluates student learning achievement from his or her e-learning product by administering his or her performance assessments as pre- and post-tests, and then computing the differences (i.e., measures of individual student learning gains). Finally, the student is expected to write a final report that summarizes the design process, describes how *First Principles* have been applied, and discusses the formative evaluation and usability testing of the product and results of his or observations. See an example of a final report at https://www.indiana.edu/~istr547/frick08summer/Wendy_R547_FinalReport.pdf (Frick, 2008d). This report describes the objectives of the e-learning product, the performance assessment, how it meets the requirements of *First Principles of Instruction*, the usability evaluation of her product, and the results.

The reader should note that R547 is not a beginning class. It is an intermediate level course, which master's and doctoral students take after core courses in instructional design. Otherwise, the gaps between the tasks would probably be too great for students. The R547 course is taken entirely online and has been taught this way since 2006 when it was offered online, using *First Principles of Instruction.*

Examples of *Activation*, *Demonstration*, *Application* and *Integration Principles* in R547 are listed below:

- *Activation*: initial movie in course overview; students view work by prior students in R547 (see links in syllabus); activation is used in the mini-movies, especially at the beginnings; instructor uses activation techniques when responding to student questions in online discussion in Google Groups.
- *Demonstration*: mini-movies[4] show how to use Acrobat Connect, VPN, Dreamweaver and CSS; demonstrations are abundant in the textbook by Bardzell and Bardzell (see print resources in the syllabus).

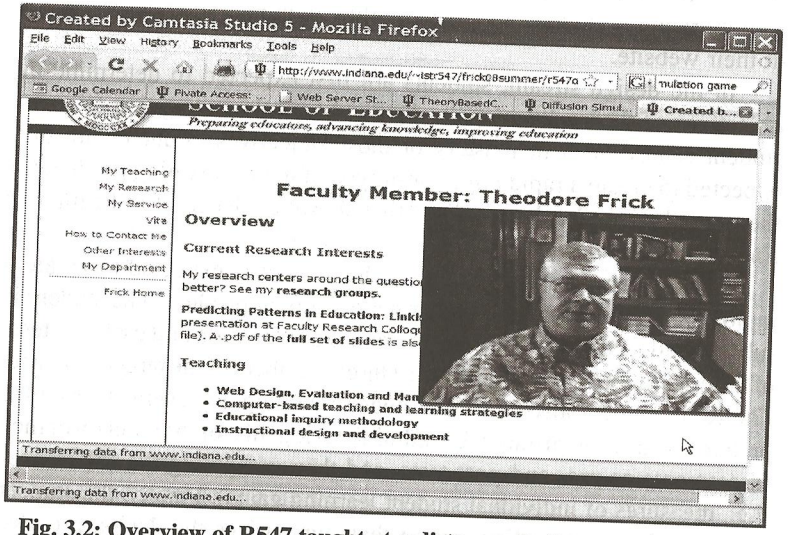

Fig. 3.2: Overview of R547 taught at a distance: Online movie (podcast) with audio and video overlay to introduce the course
https://www.indiana.edu/~istr547/frick08summer/r547overview2008/r547overview2008.html (Frick,2008e)

- *Application*: students create the web deliverables, objectives, assessments, paper and computer prototypes; students conduct formative evaluation of their e-learning products with real subjects; students analyze results of formative evaluation and usability testing and write a summary report.
- *Integration*: students post their deliverables in the Wiki (Google Pages), so other students can view each other's work; students present their final e-learning product in Acrobat Connect to the instructor and students at the end of the course; perhaps most important of all, integration often occurs when students immediately use what they have learned in their jobs[1].

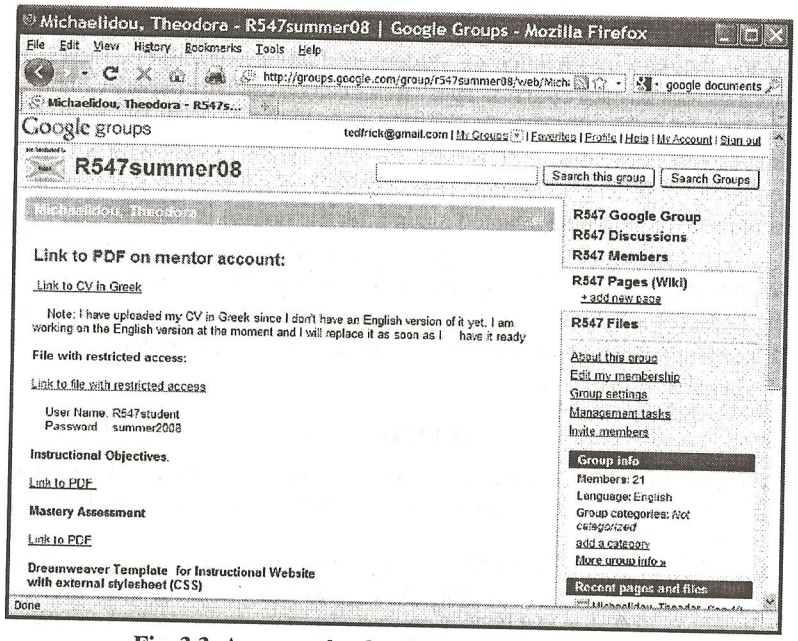

Fig. 3.3. An example of an R547 student posting to her wiki page in Google Groups

An example of links to a student's deliverables that she posted on her Google Page (wiki) is illustrated in Figure 3.3. Everyone in the class can see what other students have done. The Google Group is set up so only students and the instructor in the R547 can see it. While instructor feedback on early versions of a student's deliverable is posted in Google Discussions (so the whole class can benefit from the instructor's comments), the feedback and grade on each deliverable are provided in the Oncourse grade book and which are privately shared between the instructor and each student.

Summary

We have discussed how *First Principles of Instruction* is supported by extant theories of learning and instruction from three different paradigms—behaviorist, cognitivist, and constructivist.

Several empirical studies were reviewed in which *First Principles of Instruction* have been investigated. *First Principles of Instruction* are highly associated positively with student perceptions of overall quality of instruction, satisfaction with the course and instructor, student learning progress, student academic learning time, and student learning achievement. These relationships appear to be consistent, regardless of whether a course is taught face-to-face or online.

Items from the Teaching and Learning Quality (TALQ) scales were listed that can be included on student evaluations of online courses, as well as face-to-face courses. These items can be used in course evaluation as a means of feedback to instructors on use of *First Principles.* TALQ scales can be used to indicate areas of improvement needed in existing courses. Moreover, an existing course could be evaluated by TALQ scales, and then it could be evaluated again after the course is redesigned.

An existing face-to-face course that utilizes *First Principles of Instruction* was described and followed by discussion of what would need to be accomplished in conversion to an online version of the course. Finally, an existing online course was described that implements *First Principles of Instruction.*

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NOTES

1. These students typically are working in professional jobs and taking IST distance courses one or two at a time as they seek a certificate and/or a master's degree.
   Each time the course is taught a different real-world client is sought. For example, the previous year the client was our Education Technology Services (ETS) and the website was for the School of Education. During the 2009 fall semester, the client is expected to be the Association for Educational Communications and Technology (AECT), which is redesigning its website.
2. The university provides a web account that he uses for publishing his course website. The university also currently has a site license with Adobe so that tools such as Dreamweaver, Contribute, etc. can be installed on personal computers that faculty, staff and students use while at Indiana University.
3. To see an example of this, go to https://www.indiana.edu/~istr547/frick08summer/r547overview2008/r547overview2008.html (Frick , 2008b). The site provides an overview of an existing online course, R547, Computer-Mediated Learning that was designed and has been taught by the first author. Once these movies have been created, they can simply be uploaded to the course website and hyperlinks can be made in the Resources folder (e.g., see R547 discussion below).
4. R547 mini-movies are viewable at: https://www.indiana.edu/~istr547/frick08summer/resources/index.html. A username (*professor*) and password (*frick*) are required.