A Workshop in Wireless LAN Design and Implementation: Application of the Design Theory of Problem Solving

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Assignment B: Application of Learning Theories

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Introduction

This workshop is to develop the skills in design and implement a small-scale wireless local area network (LAN). The target learners are semi-professional network administrators in K12 schools in rural area of Shanghai, China. Semi-professional means these network administrators are information technology teachers or computer science teachers who only have some essential network knowledge, because of the school budget. They do not have professional training or development experience in network administration, but they work as network administrators. The theory applied in this workshop is the design theory of problem solving by David H. Jonassen, which is based on conditions-based theory.

Discussion of the Learning Theory

Jonassen's design theory of problem solving is a refinement of conditions-based instructional design theory. I will discuss it starting with Gagné's types of learning outcomes and instructional events.

Types of Learning and Instructional Events

Gagné (1985) proposes the types of learning. They are 1) intellectual skills, 2) cognitive strategies, 3) verbal information, 4) motor skills, and 5) attitudes. Among these five main categories, intellectual skills have a hierarchical, prerequisite relationship. There are four subcategories in intellectual skills, discriminations, concepts, rules, and problem solving. Gagné described the types of leaning outcomes as qualities that reside within the learner. He described verbal information and intellectual skills, which have "distinctly different memory storage systems" (Ragan & Smith, 2001, p. 545). Problem solving category have continued to be developed as a separated category and combined with cognitive strategy (Ragan & Smith, 2001).

Besides the types of learning outcomes, Gagné also introduced the 9 events of instruction (Gagné & Briggs, 1974), which are:

1. Gain attention
2. Inform learner of objective
3. Stimulate recall of prerequisite learning
4. Presenting stimulus material
5. Providing learning guidance
6. Eliciting performance
7. Provide feedback
8. Assessing performance
9. Enhancing retention and transfer

Smith and Ragan (2005) expand the events of instruction. They proposed a framework of generative instructional events by moving focuses from what is done to the learner to what will the learner do during the instruction (table 1).

Table 1.

Expanded instructional events (adapted from Smith & Ragan, 2005, p. 148, figure 7.3)

Introduction	**Body**	**Conclusion**	**Assessment**
• Activate attention • Establish instructional purpose • Arouse interest and motivation • Preview lesson	• Recall prior knowledge • Process information • Focus attention • Employ learning strategies	• Summarize and review • Transfer knowledge • Remotivate and close	• Assess performance • Evaluate feedback and remediate

	• Practice • Evaluate feedback

Problem-Solving Skills

Smith and Ragan (2005) describe problem solving as “the ability to combine previously learned principles, procedures, declarative knowledge, and cognitive strategies in a unique way within a domain of content to solve previously encountered problems” (p. 218). Through this description, problem solving involves prior domain knowledge and learner’s cognitive styles. It involves “mapping an existing problem schema onto a problem and using the procedure that is part of the problem schema to solve it” (Jonassen, 2000, p. 66). Existing problem schema comes from previous problem solving experiences or workout examples. Jonassen (2000) summarized that problem solving varies along at least three different dimensions: 1) problem type, 2) problem representation, and 3) individual differences.

Type of Problem

According to Jonassen (2000), there are well-structured problems and ill-structured problems (Table 2).

Table 2

Well-structured problems and ill-structured problems (adapted from Jonassen, 1997, pp. 68-69)

	Well-structured problems	**Ill-structured problems**
Elements	• Present all elements	• One or more problem elements are unknown
Solution	• Have probable solutions, or preferred, prescribed	• Have multiple solutions, solution paths, or no

	solution process • Possess correct, convergent answers	solution at all • Possess multiple criteria for evaluating solutions
Knowledge involvedness	• Involve concepts, rules, and principles in limited domains of knowledge • Rules and principles are well-structured and predictable	• Present uncertainty about concepts, rules, and principles • Involve multiple domains of knowledge
Problem definition	• Clear	• Unclear • Require learners to express personal opinion and make judgments about the problem
Situation	• Educational situation • More in textbooks	• Real life situation • More in daily life

Well-structured problems are typically found in educational settings. They consist of “a well-defined initial state”, “a known goal state”, and “a constrained set of logical operators” (p. 67). For example, *car A is traveling at 60 mile/hour, car B is traveling at 90 mile/hour. Car A is 30 miles ahead to car B. How long for car B to overtake car A?* Ill-structured problems are typically found in real life. They have unknown problem elements, could have multiple solutions (or no solution). There are uncertain concepts, rules, and principles. For example, *design a handout for* *a presentation*. Well-structured and ill-structured problem need different intellectual skills. Learners need to integrate different content domains. Problem structuredness overlaps with complexity. Ill-structured problems tend to be more complex with well-structured problems.

Jonassen (2000) lists 11 different types of problem, including 1) logical, 2) algorithmic, 3) story, 4) rule-using, 5) decision making, 6) troubleshooting, 7) diagnosis-solution, 8) strategic performance, 9) case analysis, 10) design, and 11) dilemma. These 11 types tend to be more complex and dynamic from the first type to the eleventh type.

Instructional Design Models for Problem-Solving Learning Outcomes

Well-structured problems and ill-structured problems have different attributes in nature, so they need different problem solving processes and skills. Table 3 presents the different processes of the two type of structured problems.

Table 3

The comparison of problem solving processes of well-structured problems and ill-structured problems (adapted from Jonassen, 1997, pp. 69-83)

Process for solving well-structured problem	**Process for solving ill-structured problem**
1. Problem representation. 2. Search for solutions. (Learners could skip this step if their problem schema were activated) 3. Implement solutions. 4. If the solutions failed, repeat step 1-3 or 2-3.	1. Learners articulate problem space and contextual constraints. 2. Identify and clarify alternative opinions, positions, and perspectives of stakeholders. 3. Generate possible problem solutions. 4. Assess the viability of alternative solutions by constructing arguments and articulating personal beliefs.

	5. Monitor the problem space and solution options.
	6. Implement and monitor the solution.
	7. Adapt the solution.

Based on the typology of problems, Jonassen (1997) proposes an ID model for well-structured problems solving and ill-structured problems solving instruction (Table 4).

Table 4

ID Model for problem solving (adapted fromJonassen, 1997, pp. 73-86)

Well-Structured Problem Solving	**Ill-Structured Problem Solving**
1. Review prerequisite component concepts, rules, and principles.	1. Articulate the problem context
	2. Introduce problem constraints
2. Present conceptual or causal model of problem domain.	3. Locate, select, and develop cases for learners.
3. Model problem solving performance using worked examples.	4. Support knowledge base construction.
	5. Support argument construction.
4. Present practice problem.	6. Assess problem solution.
5. Support the search for solution.	
6. Reflect on problem state and solution.	

Theory Appropriateness

The topic of this workshop is to design and implement a wireless network in a school environment. It needs practical problem-solving skills. It requires learners to integrate multiple principles and procedures to solve the problem. The target learners are semi-professional network administrators in K12 schools. They do not have professional training in computer networking. Most of their knowledge and skills in network management are not from traditional classroom, instead, they learned from practice. Once they have the ability to solve the problems in the workshop, they may apply that ability to similar types of problem (Gagné, 1985; Smith & Ragan, 2005).

The Design Frame of the Training Session

Training Goal

The learner can design and implement small wireless networks in classroom or office settings to provide secure Internet accessing for wireless devices in range.

Needs of the Training

In Shanghai, many rural area K-12 schools do not have professional network administrators. Typically, an information technology teacher works as the network administrator. Recently, more and more wireless devices are used in daily education, such as laptop computer, netbooks, tablets, and mobile phones. Most of the schools do not have the budget to work with a professional networking company to construct a school level wireless network. Therefore, school administrators want to train their network administrators to be able to design and implement small-scale wireless networks in some areas of the campus (e.g., some classrooms, offices, or library) and maintain these networks.

Learner Characteristics

Cognitive characteristics. All learners are teachers in K-12 schools in Shanghai. The average age is 30 (the youngest is 25 and the oldest is 45). Most of them have a bachelor degree in computer science, educational technology, or physics education. The will be able to process abstract information and to use logic to analyze problems and apply the knowledge into problem solving.

Prior knowledge and skills. All learners will have the essential knowledge that is required by this workshop, such as computer hardware and software, computer networking hardware, computer networking protocols, and troubleshooting skills. A prerequisite notice will be distributed along with the announcement of this workshop.

Affective characteristics. Learners are motivated by interests or work requirements. They do not have professional training in computer networking, but they choose to be a network administrator. They like to deal with technology and want to keep up with the latest technologies. They are motivated to finish this workshop.

Processing style of instruction for the learner. The target learners are heavily depends on learning by doing. Most of their knowledge and skills in computer network are not from traditional classroom, instead, they learned from practice. Therefore, this workshop should provide practice opportunities for the learners.

Learning Context Analysis

Existing training resources. Cisco Networking Academy (2009) has an chapter for wireless technologies, which is appropriate for this workshop. However, it is organized in a traditional topic-based format. We will use some of the content (e.g., concepts and examples) in this workshop with different strategies.

Physical location and hardware. This workshop will be delivered in the network and communication laboratory of College of Mathematics and Science, Shanghai Normal University.

All computers, wireless devices, and network devices are provided. Internet connection is also available.

Performance environment. Learners will perform their learning in their school environment. There could be some varies as in the laboratory, such as the maker and the model of the wireless access point, number of access points, security requirements, and IP configurations. It's a typical environment for ill-structured problems.

Objectives

The learner will be able to:

- Explain the key terms related to IEEE802.11 wireless specifications.
- Identify different types of wireless network devices.
- Identify security issues in a wireless environment.
- Design and implement a small-scale wireless local area network.

Instructional Strategies

Organizational strategies. The workshop consists of five primary sections, introducing wireless network, review prior knowledge, workout examples, well-structured problem solving, and ill-structured problem solving. We will use a generative approach in the workshop. The assessment will be two peer-evaluation performance-checklists.

Delivery strategies. The primary delivery method will be through printed handouts. Learners will have a workshop folder, including introduction, activities guidelines, reflecting sheet, and additional resources. Digital format of the training material is available on Google drive. There will be a Google group discussion and a group blog for extended discussions before and after the workshop. Learners will be divided into small groups with 2-3 people.

Management strategies. This workshop will be completed in a 4-hour session. The cost is free for attendance. Prior registration is required. All activities and problems will be taken care of within the workshop time. Discussions will be continued through Google group discussion and blogs.

Activities

Activate attention. Play a video to show how people use wireless network in home and office. After that, learners will brainstorm use cases of wireless network in their schools.

Establish instructional purpose. Let some learners talking about why they choose to attend this workshop, what they think they can learn from this workshop. Then, the instructor will introduce the training goal, group activities, and the laboratory environment.

Arouse interest and motivation. Show learners a finished wireless network. Let learners use their own mobile devices to connect the Internet. Through the instructor's screen, learners can see who connected to the access point (or router).

Recall prior knowledge. On the instructor's screen, learners will be guided to focus on the network information of each devices that connected to instructor's access point. Instructor will post several questions:

- How many IP addresses does the access point have?
- What is the IP address of your device?
- What is the gateway address of your device?
- Which network do all the devices belong? Please present the network address with subnet mask.

All these questions are prior knowledge.

Process information. Instructor will show a network diagram in Packet Tracer[1].

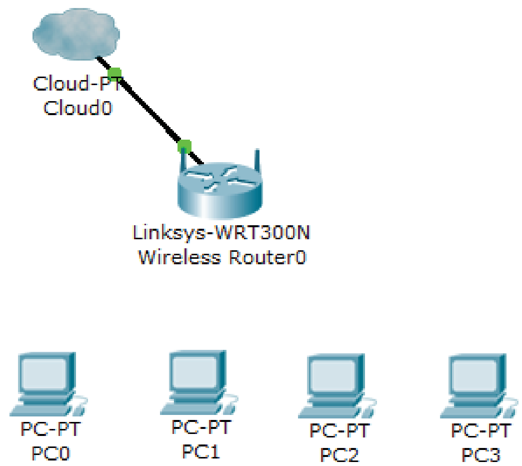

Figure 1. A wireless network diagram

In this diagram, instructor will explain what devices are required by a wireless network. Several terms will be addressed in this phase.

Focus attention. Instructor will divide leaners into small groups. Learners will work on problems in the groups. Each group will have a suite of network devices, including router, switch, wireless router, four computers, USB wireless network adapters, and some wires. Learners will be asked to identify each device.

Present well-structured problem. The first problem is to setup a wireless local area network.

Problem 1: You are asked to create a wireless local network than can support wireless devices access the Internet. Choose the wireless access point from provided devices. Configure the access point so your wireless devices can connect to it. The IP address for the local area port is 192.168.1.1/24. The IP address for the wide area network port is 202.121.54.120/24. No password is required to be connected in the wireless network.

[1] Packet Tracer is a network simulation software developed by Cisco. http://www.cisco.com/web/learning/netacad/course_catalog/PacketTracer.html

The group will work together to solve this problem. Each group will peer evaluate other two groups' solutions with the following checklist.

Problem 1 Peer Evaluation Checklist

- ☐ Wire connections of access point is correct
- ☐ All ports light of the access point is green
- ☐ The IP address on local area network port is correct
- ☐ The IP address on wide area network port is correct
- ☐ Wireless client can discover the SSID
- ☐ Wireless client can connect to the access point without password
- ☐ Wireless client can access the Internet through the wireless network

Figure 2. Performance checklist for problem 1.

The problem 1 is a well-structured problem. All items in the peer evaluation checklist are predictable. All group will reach an approximately same solution.

Ill-structured problem. The second problem is to setup a secure wireless local area network with provided devices.

Problem 2: Your school wants to setup a wireless network at the lobby of the library. Only users who have the SSID name and the password can connect to the access point. To prevent potential invalid access, how would you configure the wireless access point?

This is an ill-structured problem. Learners need to address as many potential invalid accessing ways as possible. Then search correspond solutions for each threat. There are many possible threats and many solutions to deal with these threads.

There is another performance checklist for peer evaluation.

Problem 1 Peer Evaluation Checklist

☐ Wire connections of access point is correct

☐ All ports light of the access point is green

☐ The IP address on local area network port is appropriate

☐ The IP address on wide area network port is appropriate

☐ The SSID setting is appropriate

List all tested threats and the results

Threat	Solved? (Yes/No)

Figure 3. Performance checklist for problem 2.

Feedback. The instructor will choose 2-3 groups to discuss their solutions and their evaluations for other groups. During the problem solving activities, the instructor will provide individual feedback.

Remotivate and close. Tell learners that there are a Google group discussion board and a group blog available for this workshop. Learners can continue the discussion of the problems in this workshop, or start new topics in both discussion board and group blog. Experience and working cases are welcome.

Assessment. Assessment is done by the two peer evaluation checklists.

Formative Evaluation Plan

The formative evaluation process includes expert review and small group try out. Two or three subject matter expertise in computer networking will review the content of the workshop.

An instructor will try this workshop with a small group of learners from one or two schools.

Time data will be collected in table 5.

Table 5

Form for time data collection (in minutes)

Activity	Time used in try out	Estimate time in workshop
Activate attention		
Establish instructional purpose		
Arouse interest and motivation		
Recall prior knowledge		
Process information		
Focus attention		
Well-structured problem		
Ill-structured problem		
Feedback		
Remotivate and close		

Note: Some estimate time could be double in real workshop, because of the number of groups.

The try-out learners will do a simple questionnaire after they finish the workshop (figure 4).

1. How were the discussions during the workshop?
2. What did you think about the devices used in the workshop?
3. Did you solve the first problem? If not, why?
4. Was there any unclear element in problem 1?
5. How was the peer evaluation going on in the first problem?

6. Did you solve the second problem? If not, why?
7. How was the peer evaluation going on in the second problem?
8. Would you participate the extended group discussion and group blog?
9. To what extend do you think you have learned what you expected for this workshop?

Figure 4. A questionnaire for try-out learners.

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