Training Manual for Effective Instructional Strategies

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Preface

Introduction

To master instructional strategies design is to master your instruction. This training manual is about a set of effective instructional strategies. It guides you how to use these strategies to solve instructional problems. Choosing effective instructional strategies is a critical part in instructional design. It depends on your target learners, learning context, learning goal, and learning tasks. These five strategies in this manual are used commonly in instructions at variety of fields and levels. They are discussed in details on what they are, when to use, and how to use. After you finish this manual, you will be able to apply these strategies in your instruction effectively and appropriately.

Who This Manual Is For

If you are an instructional designer and you are seeking effective ways to design and development your instructional strategies, this manual is for you.

If you will be an instructional designer soon and you want to learn more strategies in the real world, this manual is for you.

If you are an instructor and want to improve your instruction, this manual might be helpful to you as well.

An Overview of This Manual

This manual has five chapters, each chapter is for one particular instructional strategy. They are analogy, questioning, worked Examples, graphic organizers, and problem-based learning.

All chapters have similar structures, what the strategy is, theory and research on the strategy, the conditions for using the strategy, and how to use the strategy. Exercises are provided in each chapter and a final project is at the end of the manual to apply these strategies in your own instruction.

Contacting the Author

This is the first edition of the training manual, it must have many issues to be improved. If you have any questions or suggestions, please contact the author at hye@sycamores.indstate.edu.

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Chapter 1 Analogy

> Sometimes I'm confused by what I think is really obvious. But what I think is really obvious obviously isn't obvious…
>
> — Michael Stipe

Objectives

- To develop appropriate analogies.
- To apply analogies in instruction.

Introduction

Read the following two paragraphs for the same concept: the aperture of a camera.

Paragraph 1:

Aperture is a hole or an opening that allow light to pass through to a film, or an image sensor for a digital camera. Aperture can control the amount of light passing through by expanding or contracting the opening.

Paragraph 2:

Aperture works like the pupil of an eye. Both of aperture and pupil are an opening (hole) that allow light to pass through to a receiver, the film (or an image sensor for a digital camera) or retina. Aperture (or pupil) can control the amount of light passing through by expanding or contracting the opening.

What's the difference between the two paragraphs presented above?

The second paragraph is using analogies. This chapter will introduce the analogy strategy in instruction and learning, the conditions of using analogies, and how to apply analogies in instructional design.

What is Analogy

Analogy in instruction is to help the learner understand abstract concepts by relating to concrete and familiar reference. For example, analogies are used in the second paragraph of the previous example. There are two analogies in the sample, aperture to pupil and film (image sensor) to retina.

Theory

Conceptual-change theory posits an accommodation view of learning concept. Mayer (2008) summarized that in accommodative learning, “the user must build a new conception that can accommodate the newly presented information” (p. 223) and “analogies are a major vehicle for lending meaning to a new conception” (p. 224). Mayer (2008) noted that an analogy occurs when the learner can map the new concept to a familiar concept. The new concept is called a base, and the familiar concept is the target. The base and the target are matched to corresponding objects, attributes, and relations. When learners have little related prior knowledge for the new concept, analogy can help learners understand the new concept by relating it to a familiar concept in other domain with corresponding parts or relations.

Research on Analogy

Analogy is a way to learning a new concept with the learner's old knowledge. Sometime comprehending a new concept only after the new concept has been stated in the context of one or more familiar concepts (Donnelly & McDaniel, 1993), especially when the learner is lacking knowledge in the new domain. Donnelly and McDaniel (1993)conduct a series experiments to examine the role of analogy in learning science concept. In experiment 1, the subjects were 48 undergraduate students. The subjects would learn 12 scientific concepts. Learning materials were text with and without analogy. Both basic level and inference level questions were tested. The results show that students in analogy group got lower scores in basic level questions, but were better in inference level test than the students in non-analogy group. This means that analogy is helpful to improve students' meaningful learning.

Donnelly and McDaniel's (1993) second experiment is to test effect of analogy on learners with different background knowledge (low, medium, and high). The materials were 24 cartoon videos which explain 12 scientific concepts, 12 using a literal depiction and 12 using analogical depiction technique. As in experiment 1, basic level questions and inference level questions were tested. The results show students in literal condition did better in basic level question, but novice in the analogy condition were significantly better on inference level questions. The results of Donnelly and McDaniel's (1993) experiment 2 indicate that literal depiction if better for lower level learning and analogical depiction can help novice understand new concept in new domain meaningfully.

In Donnelly and McDaniel's (1993) third experiments, the comparison is on the effect of visual components and analogies. Two types of materials were prepared. One was scientific concepts in literal text with concrete audio-visual supplements; the other was statements with analogies. The results show that students in literal with audio-visual supplements did better on basic level questions, and students in analogy condition did better on inference level questions. Although the difference is not significant, we still can infer that analogy have "an advantage on inference-level knowledge and a disadvantage on basic-level knowledge" (Donnelly & McDaniel, 1993, p. 982).

Researchers also have negative expressions on the relation between analogies and learning (Donnelly & McDaniel, 1993). The reason is that "analogy may lead students to draw incorrect inferences by applying the source domain where it [the new concept] does not belong" (Donnelly & McDaniel, 1993, p. 975). To examine this question, Donnelly and McDaniel's (1993) conducted the fourth experiment. In the experiment, 160 subjects were grouped into domain-unfamiliar literal group, domain-unfamiliar analogy group, and domain-familiar literal group. The results show that subjects in domain-unfamiliar analogy group had slightly lower performance than those in domain-familiar group. Donnelly and McDaniel's (1993) suggest that "knowledge from an old domain can be applied to infer facts about concepts from a new domain" (p. 983) and "subjects in the analogy condition need not to have paid explicit attention to the new-domain information contained in the analogies to perform well in answering questions about the new domain" (p. 983).

Donnelly and McDaniel's (1993) study inferred that:

- Analogy is better for inference-level learning than basic-level learning.
- Analogy is effective to use knowledge in old domains to learn concepts in a new domain.
- Analogy is effective when the learner lacks background knowledge of a new domain.
- Analogy may be effective even without visual supplemental materials.

When to Use Analogy

Table 1.1

The conditions of using analogy

	Conditions
Learning context	• Original learning materials are using abstract literal depiction techniques for concepts • Time limitation. There is no extra time to develop sophisticated visual representation of concepts
Learning goal	• Meaningful learning. Learners need to understand the concept meaningfully and can apply in higher-level skills
Learner	• Learners are lack of background in new learning domain
Learning task	• Declarative knowledge • Concept (especially for abstract concepts)

How to Use Analogy

The process of applying analogy includes analyzing learners' prior knowledge, analyzing base concept analysis, determining target concept, developing learning materials, implementing, and evaluating (figure 1.1). Revise as necessary.

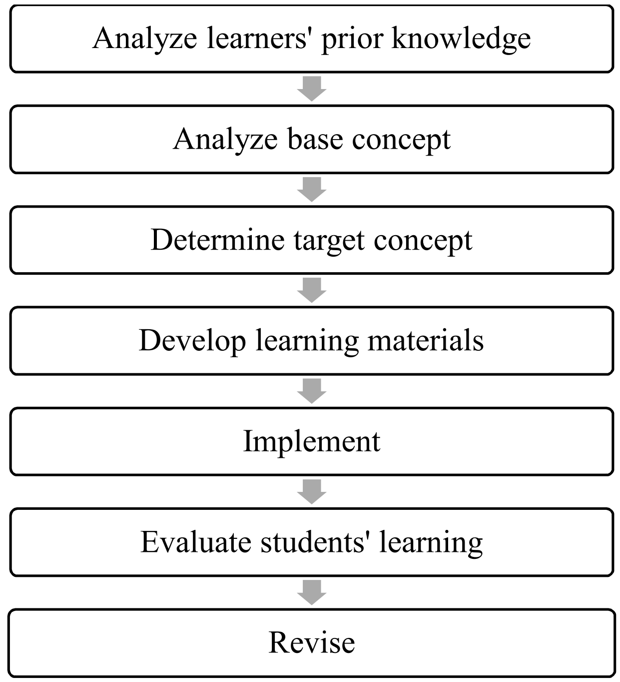


Figure 1.1. The process of applying analogy

Analyze learners’ prior knowledge. Analogy is better for learners who don’t have strong prior knowledge in the new learning domain. Additional, analogy is effective when it is connected with the learner’s familiar domains. Therefore, in this step, you need to focus on the questions like: What and how well have the learners already known in the new learning domain? What knowledge backgrounds do the learners have?

Analyze base concept. The base concept is the concept that the learner is going to learn. To make an effective and precise analogy, it must have matched attributes, behaviors, or relations on both sides. For example, the aperture is to control the amount of light passing through (behavior), the aperture can expand and contract (behavior), the aperture has a numbered value to indicate the degree of openness (attribute), and the light passing through the aperture is going to the film or image sensor (relation). By knowing these features of the base concept, we can go to the next step and identify a target concept for analogy.

Determine target concept. Target concept is used to compare with the base concept. The target concept must have some features that can be matched with the base concept. How many features or how strong the concepts should be match depends on the learning context. Typically more matched features and stronger matching are better. For example, the pupil of eye is matched on passing through light to a receiver, and the capability of controlling the degree of openness. When you determine the target concepts, remember to check the differences and the chance of misconception.

Develop learning materials. Develop learning materials with multiple media. Although delivery analogies instruction with text is powerful, present analogies in multiple media is more effective, for example, present the diagrams of structures of a camera and an eye side by side. If possible, animations for the process of light passing through the aperture / pupil and reach the receivers, and how aperture / pupil control the amount of light would be even better.

Implement. During the implementation, it is important to know where to break down the analogy. As we discussed previously, inappropriate analogy could lead misconception, overuse appropriate analogy could lead misconception as well. For example, the analogy of camera and eye might be stop while learning the concepts of shutter and the film (or image sensor).

Evaluate students' learning. Check students' understanding after analogies. If the learning goal is meaningful learning, you could present some problems. For example, for the aperture example, you can present an over-exposed photo, and ask the student how to adjust the aperture value to fix it.

Revise. Based on the formative evaluation of the whole instruction, you can revise the analogy strategy comprehensively with other parts of the instruction.

Summary

Chapter 1 introduced the analogy strategy. Analogy strategy is helpful when learners are lacking prior knowledge in target domain of the new concept. Map the new concept with familiar concepts in other domains can help the learners understand the new concept quickly and meaningful. The process of analogy strategy design includes analyzing learners' prior knowledge, analyzing base concept, determining target concept, develop learning materials, implementing, and evaluation. Revising is suggested for each step. Misconception is a problem cause by overused analogy, so you need to identify where to break down the analogy and avoid the misconception.

Exercises

1. Select two concepts that you think are needed to use analogies and give at least two analogies for each of the concept. Describe your target learners and explain why you think these analogies are appropriate.
2. For the analogies you made in the previous exercise, please describe how you would do to avoid misconceptions with the analogies.

Chapter 2 Questioning

> Judge a man by his questions rather than his answers.
>
> — Voltaire

Objectives

- To use questions in a variety of levels, including factual, empirical, productive, and evaluative questions, in instruction
- To use questions in a variety of types, including focusing, prompting, and probing questions, in instruction
- To apply questioning in instruction

Introduction

How many questions have you asked in your life? Do you think you are good at ask questions in instruction? What techniques do you use in questioning? Do you use different levels of questions in instruction? What kinds of questions do you think are effective? What do you need to avoid while asking questions in classroom? Do you want to answer these questions? This chapter will introduce the questioning strategy, why questioning strategy is effective, when and how to use questioning strategy.

What is Questioning

Literally, questioning is to promote learning by asking questions. Killen (2010) defined questioning strategy as "a carefully sequenced set of questions, designed to advance the learning goals of a class" (p.251). This definition gives us some basic ideas of questioning strategy. First, there should be a series of designed questions to advance the learning goals. Several ways can be used to advance the learning goals by questioning, such as develop interest and motivation, evaluate students' preparation, review previous lessons, provide scaffold to develop thinking skills, and assess achievement of learning goals and objectives (Moore, 2005). The second idea is that this is a carefully sequenced set of questions. *Sequenced* means the questions should have some kind of order. Difficult level of question can be a sorter; categories of questions (according learning taxonomy) could be another.

We also can use lower cognitive questions and higher cognitive questions to categorize questions based on Bloom's taxonomy. Lower cognitive questions involve recall data or information (knowledge), and higher cognitive questions involve comprehension, application, analysis, synthesis, and evaluation. Moore (2005) proposed a mental operation system to classify questions based on the work of J. P. Guilford and Benjamin Bloom (as cited in Moore, 2005). The categories of questions include factual, empirical, productive, and evaluative (Table 2.1).

Table 2.1

Categories of questions (adapted from Moore, 2005, pp. 240-243)

Mental operation questions	**Guilford's structure of the intellect**	**Bloom's taxonomy**	**Type of thinking**	**Examples**
Factual	Cognitive / memory	Knowledge / comprehension	Recall information	"Define …" "What is …" "When did … happen"
Empirical	Convergent thinking	Application / analysis	Integrates and analyze information	"Explain in your own words …" "Compare …"
Productive	Divergent thinking	Synthesis	Produce idea or response creatively and imaginatively	"How could we …" "What is better for …"
Evaluative	Evaluative thinking	Evaluation	Make judgments or express values	"Which one is the best?" "Why do you …"

According to the purpose of questioning, we can use different types of questions. Moore (2005) proposed three types of questions, focusing questions, prompting questions, and probing questions (Table 2.2). Typically, focusing questions are followed by prompting and probing questions to develop and improve students' response.

Table 2.2

Types of questions (adapted from Moore, 2005, pp. 244-245)

Type	**Purpose**	**Examples**
Focusing	Raise attention and interest Stimulate involvement Check understanding	1. "What is a rhombus?" 2. "What question would you use to raise students' interest?" 3. "How could we determine the effect of an instructional strategy?"
Prompting	Give clues	If a student's answer for question 1 is: "I don't know." The prompting question could be: "Well. What do we call a closed plane figure having three or more straight sides?"
Probing	Correct, improve, and expand initial response	"Why do you think … will work?" "Could you provide some examples …?"

Theory

Questions can raise learners' attention. The first element of ARCS model is to gaining attention, which is one of the origins of motivation (Driscoll, 2005). Questions can provide guidance for learners to thinking. Vygotsky's the zone of approximate development and scaffolding theory indicates that provide appropriate helps and clues can improve learning.

Research on Questioning Strategy

Lower level questions are overused. Danies (1986) conducted a study on the types of questions teachers of social studies ask their students. In Danies's (1986) study, there are four categories of questions, including literal (factual), interpretive (empirical), application (productive), and affective (evaluative); four teaching styles, including comprehension check, discussion, lecture, and oral reading of the text. A total of 38 teachers in 2^{nd}, 4^{th}, 6^{th}, 8^{th}, 10^{th}, and 12^{th} grades were observed. Questions types, frequencies, duration, and sequences were recorded by Timed Interval Category Observation Recorder (TICOR). Danies (1986) found that 93% of 5,289 questions were literal questions, and less than one percent questions were affective type questions. A more recent study of lower level and higher level questions at secondary schools by Khan and Inamullah (2011) has the similar result. The results show that 67 percent of all questions are at knowledge level, 23 percent questions are at comprehension level, and 10 percent questions are at higher levels. Orlich, Harder, Callahan, and Gibson (1998) note that teachers questioning skills can be improved by systematically organizing and classifying.

Samson, Sirykowski, Weinstein, and Walberg (1987) conducted a study on the effects of teacher questioning levels on student achievement by a quantitative synthesis. In this study, fourteen studies were examined to estimate the effects of teachers questioning strategies on students' achievement. The results show that higher cognitive questions have small positive effect on students' achievement. Samson et al. (1987) believed that "[m]oderate and even large effects may exist but remain to be demonstrated" (p. 290). One possible explanation of why higher cognitive questions don't have large effect on achievement is that the items in tests are assessing students' lower level skills.

When to Use Questioning

Table 2.3

The conditions of using questioning

	Conditions
Learning context	• Learners need to get focus • Need to check learners' understanding • Better to use with discussion
Learning goal	• Learning for test and for mastery • Develop thinking skills
Learner	Not specified
Learning task	• Concept • Procedure/Principle • Problem solving

How to Use Questioning

The process of using questioning includes analyzing learning task, determining the purposes, categories, sequence, and occasions, implementing, evaluating, and revising.

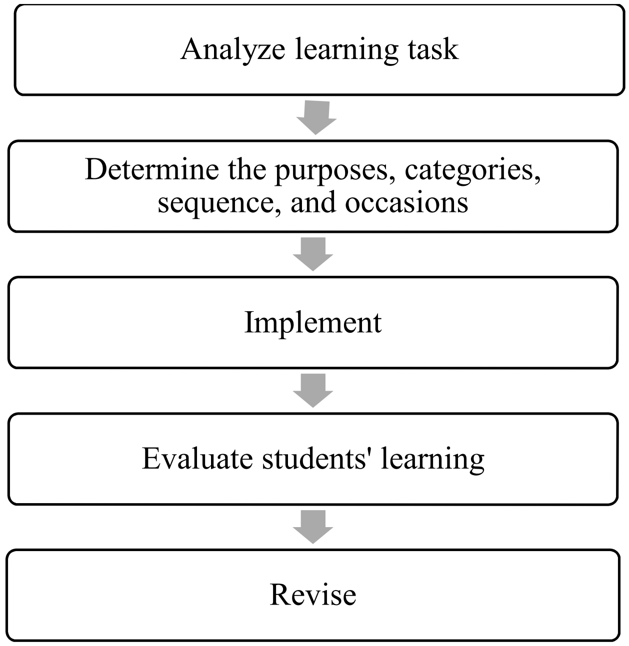


Figure 2.1. The process of using questioning

Analyze learning task. The learning tasks could be a concept, a principle/procedure, or a problem. Depending on the leaning task, you would choose different categories with specific sequence for questions.

Determine the purposes, categories, sequence, and occasions. Questioning strategy involves a series of questions other than one question. You could have questions in different categories, form factual to evaluating. Typically, you can have focusing questions at first, followed by prompting questions, and have probing questions to transfer the learning to a higher level. Occasions mean when you should ask questions. It could be at the beginning of instruction, middle, or the end of instruction. If you want to gain learners attention or check learners’ prior knowledge, you could ask questions at the beginning; if you want to provide some hints, get learners’ focus, or check learners’ understanding, you could ask questions during the instruction; if you want to summarize, or develop higher level skills, you could ask questions at the end of the instructions.

Implement. During the implementation, it is important to observe learners response if possible, especially when you implement face-to-face instruction. Some techniques you can use are, redirecting, wait-time, halting time, and reinforcement (Moore, 2005).

Evaluate students' learning. This part could be integrated with the assessment of the whole instruction.

Revise. Based on the formative evaluation of the whole instruction, you can revise the questioning strategy comprehensively with other parts of the instruction.

Summary

This chapter introduced questioning strategy in instruction. We discussed what is questioning strategy, theories and research about questioning, when and how to use questioning. Questioning strategy can be used to check understanding, get focus, raise attention, provide scaffold, and develop high level skills. The process of using questioning includes analyzing learning task, determining the purposes, categories, sequence, and occasions, implementing, evaluating, and revising.

Exercises

Choose an instructional topic. Define the learning tasks and design a questioning plan, which includes a series of questions in order with different levels, for different purposes, and at different occasions.

Chapter 3 Worked Examples

Smooth seas do not make skillful sailors.

— African Proverb

Objectives

- To develop worked examples
- To apply worked examples in instruction

Introduction

What will you do while you are facing a problem? My answer is to find a similar problem with worked solution. This chapter will discuss the worked example strategy, why worked example works, when to use worked example, and how to use worked example.

What is Worked Examples

Worked examples (or worked-out examples) typically include problems and procedures for solving the problems. A worked example has three parts, a problem, a solution, and a commentary (Mayer, 2008). Following is an example of worked example.

Problem: From a covered box containing 5 black balls and 5 white balls, two balls are randomly drawn. The chosen balls are not put back into the box. What is the probability that a black ball is drawn first and a white ball second?

Solution:

Step 1:

Total number of balls: 10

Number of black balls: 5

Probability of black ball on first draw: $P_b = 5/10$

Step 2:

Total number of balls: 9

Number of white balls: 5

Probability of white ball on second draw: $P_w = 5/9$

Step 3:

Probability that a black is drawn first and a white ball second: P = 5/10*5/9 = 5/18

Commentary:

First, calculate the probability (P_b) of a black ball on first draw by dividing the number of black balls in the box with the total number of balls in the box; then calculate the probability (P_w) of a white ball on second draw by dividing the number of white balls in the box with the total number of balls remaining in the box; finally, multiply the two probabilities and get the probability that a black is drawn first and a white ball second (P).

Figure 3.1. An example of worked example.

Theory

According to cognitive load theory, people have only a limited amount of cognitive capacity in their memories (Mayer, 2008). When people try to solve a problem which they don't have prior experience on, it might cause heavy cognitive load in working memory. Worked examples can provide sample solutions for leaners. While learners are facing near transfer problems, less cognitive load is needed, because the problems are almost the same. While learners try to solve far transfer problems, it need more cognitive load, because it needs to combine multiple principles or procedures to solve the problems. If learners can make automated schema from the worked examples, it is possible that automatic cognition would happen when learners are confront with far transfer problems and less cognitive load is needed.

Research on Worked Examples

Worked examples can lead to faster learning. Cooper and Sweller (1987) found that students who learned from worked examples took half as much time as students who learned by doing. Learning by examples also has better near and far transfer performance. The reasons behind it are cognitive load and automaticity. In Paas and van Merrienboer (1994) concluded that learning by worked examples need less effort than learning by doing. This means learning by doing needs higher level of cognitive load than learning by worked examples. For near transfer, the tasks are similar in both structure and surface with examples, learners automatically use the solutions they learned in worked examples with lower cognitive load. Far transfer needs more cognitive load, because the tasks are more complex, and learners need to integrate multiple procedures. The results in Paas and van Merrienboer's (1994) study consist with Cooper and Sweller's (1987) study that students who learn by worked examples spend less time in learning, and need lower cognitive load in both learning and transfer test, and have better performance than students who learn by doing.

Researchers focused on the effectiveness of worked examples for the last two decades. Based on these research, Chun-Yi and Hui-Chun (2009) generated eight instructional design principles of worked examples (table 3.1).

Table 3.1

Instructional design principles of worked examples (adapted from Chun-Yi & Hui-Chun, 2009, pp. 239-243)

Principle	**Suggestions**
Imagination	Combine imagination with examples. Imagination is effective when students have high-level prior knowledge, or the tasks are less complex.
Completion	Use incomplete examples as well as complete examples. In some conditions, studying incomplete examples might have more quality of self-explanations and near and medium transfer than complete examples, for example, backward fading examples.
Fading	Employ different fading paces for students with higher or lower prior knowledge levels, fast fading for higher level and slow fading for lower level.
Process	Present the process of solution with sub-goals and explanations. Focus on the "why" and "how" information of the example's solution.
Presentation	Integrate diagrams and text in example.
Media	Integrate visual and verbal in example.
Timing	Present target problems followed by worked examples rather than problem only or worked examples only.
Self-explanation	Combine worked examples with self-explanation prompts.

When to Use Worked Examples

Table 3.2

The conditions of using worked examples

	Conditions
Learning context	• Faster learning
Learning goal	• Better transfer
	• Less cognitive load
Learner	• Learners with higher or lower level of prior knowledge
Learning task	• Procedure
	• Problem solving

How to Use Worked Examples

The process of using worked examples includes analyzing the sample problem, preparing near transfer and far transfer problems, developing sample solution, providing explanation for each step, implementing, evaluating, and revise (figure 3.2).

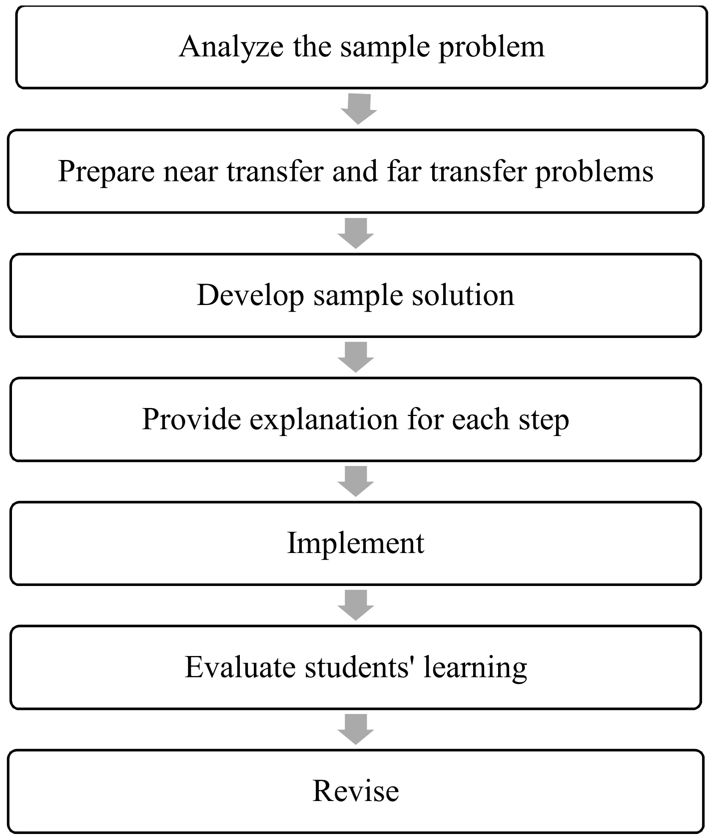


Figure 3.2. The process of using worked example

Analyze the sample problem. In worked example, the problem is the center components. You need to focus on the questions like: What learning tasks does the sample problem cover? Is it too simple or too complex? Is it typical enough to present other problems?

Prepare near transfer and far transfer problems. The purpose of worked example is to foster problem solving transfer. You could prepare near transfer and far transfer problems and compare them with the worked example to check their validation. Typically, a near transfer problem has the same structure and surface with the worked example problem; a far transfer problem has different structure and surface with the worked example problem (Paas & van Merrienboer, 1994). You also could prepare some medium transfer problems, which have same structure and different surface.

Develop sample solution. Identify steps of the worked example. Each step should have a complete function, which includes input, process, and result. For example, in the following step (figure 2.3), the inputs are the total number of balls, and the number of black balls; the process is dividing the number of black balls by total number of balls; and, the result is P_b .

Step 1: Total number of balls: 10 Number of black balls: 5 Probability of black ball on first draw: $P_b = 5/10$

Figure 3.3. A sample step.

Provide explanation for each step. Explanation can improve the effectiveness of learning in worked example (Mayer, 2008). Provide explanation for each step or the whole process, for example, to explain the step 1 you could say: "Calculate the probability (P_b) of a black ball on first draw by dividing the number of black balls in the box with the total number of balls in the box". You also can provide some clue questions to help students generate their own explanation, because self-explanation is more effective.

Implement. During the implementation, it is important to observe learners response if possible. If the students need extra explanation, you could give them more tips and encourage them to form their own explanations. You also could let students compare different worked examples, or compare the worked example with target problems, to improve the transfer of learning (Mayer, 2008).

Evaluate students' learning. Check students' learning after worked examples. Learners' performances on near transfer and far transfer are the indicator of the effectiveness of a worked example, but it's not the only reason. Be aware of any other factors that could affect the learning result.

Revise. Based on the formative evaluation of the whole instruction, you can revise the worked example strategy comprehensively with other parts of the instruction.

Summary

This chapter introduced the worked examples strategies. We discussed what is worked examples, the theory and research on worked examples, when and how to use worked examples. The process of using worked examples includes analyzing the sample problem, preparing near transfer and far transfer problems, developing sample solution, providing explanation for each step, implementing, evaluating, and revise. Backward fading and self-explanation are effective in implementing worked examples.

Exercises

1. Describe at least one theory that can explain why worked examples are effective.
2. Design a worked example for a problem in your field. Describe your target learners. Provide at least one near transfer problem and at least one far transfer problem. Explain how your worked example helps learners improve their problem solving skills.

Chapter 4 Graphic Organizers

> Teachers open the door, but you must enter by yourself.
>
> — Chinese Proverb

Objectives

- To use at least three types of graphic organizers
- To design and develop customized graphic organizers for particular learning tasks
- To apply graphic organizers in instruction

Instruction

Please compare the Smith and Ragan's ID model and Dick, Carey and Carey's ID model using following diagram.

Put differences in either side box and similarities in cross

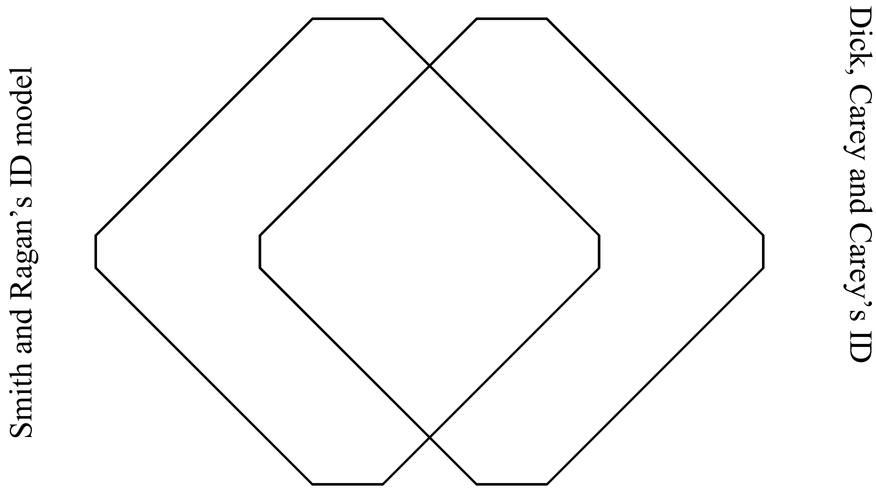


Figure 4.1. Comparing two instructional design models

This is a venn diagram, a basic graphic organizer, which is commonly used to compare two concepts or two ideas. This chapter will discuss the graphic organizer, theories and research about graphic organizer, when to use graphic organizer, and how to use graphic organizer. You will find more helpful graphic organizers in this chapter.

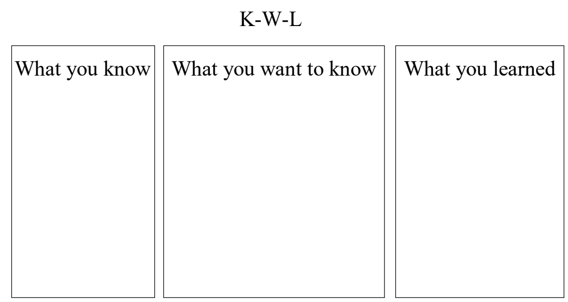
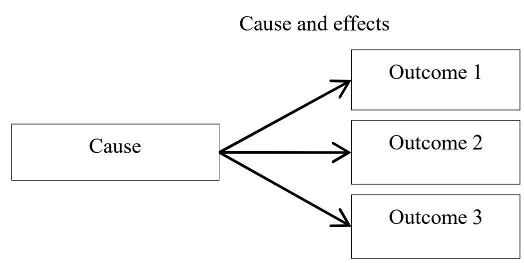
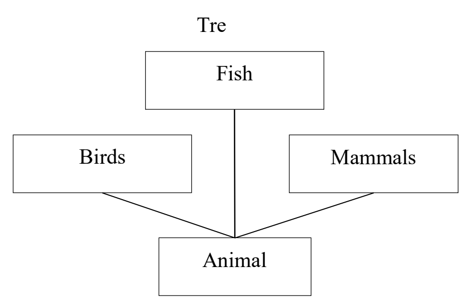
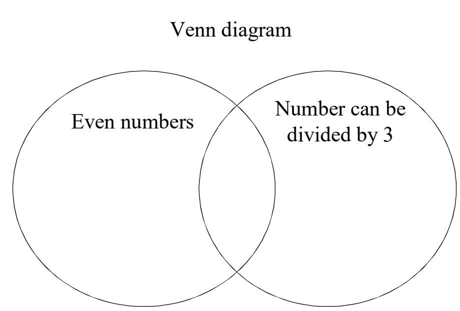
What is Graphic Organizer

Gallavan and Kottler (2007) defined Graphic organizers as visual models that "provide teachers and students with tools, concepts, and language to organize, understand, and apply information to achieve a variety of purposes and outcomes" (p. 117). Graphic organizers are tools to represent learners' thinking through a visualized form, which can make relationships between related facts and concepts more apparent (Dexter & Hughes, 2011). They can help learners manage and organize information.

Gallavan and Kottler (2007) presented eight types of graphic organizers (as shown in table n).

Table 4.1

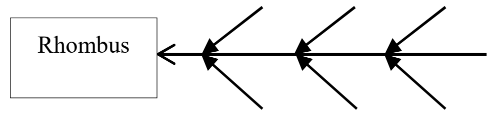
Eight types of graphic organizers (adapted from Gallavan & Kottler, 2007, pp. 118-119)

Type	**Purpose**	**Example**
Assume and Anticipate	• Check prior knowledge • Motivate and inspire interest	
Position and Pattern	• Check relationships and patterns	
Group and Organize	• Present concepts • Category or classify items	
Compare and Contrast	• Compare and contrast information	

Relate and Reason

- Demonstrate inductive and deductive thinking patterns

Fishbone

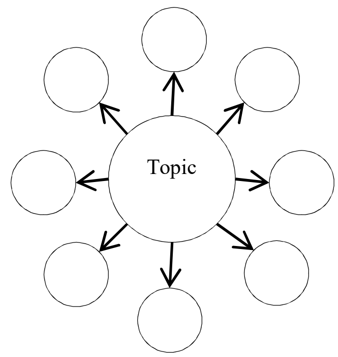


List characteristics of a rhombus

Identify and Imagine

- Brainstorm

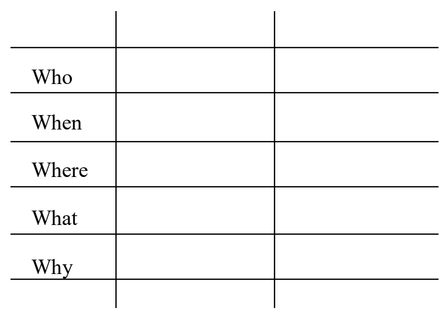
Web



Estimate and Evaluate

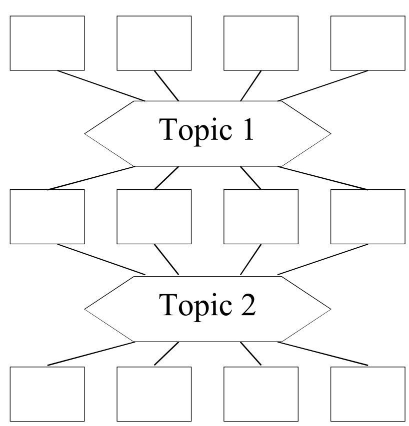
- Explain or differentiate an idea

5W



Combine and Create

- Customization



Research: Do Graphic Organizers Work?

Moore and Readence (1984) conduct a quantitative and qualitative review of graphic organizer research. A total of 23 graphic organizer studies were included in the review. The qualitative results show that "learners treated with graphic organizers outperformed learner in control-group situations by about two-tenths of a standard deviation" (Moore & Readence, 1984, p. 13). The qualitative results that:

> Specifically, classroom teachers who engaged students in GOs tended to feel more confident and competent while leading students through sections of content while leading students through sections of content. Instructors were reported to perceive themselves better organized, more in control of the learning activity, and more sensitive to the demands of the learning task. Gals were taught to be better clarified. (Moore & Readence, 1984, pp. 14-15)

Based on the results, Moore and Readence (1984) suggest that post graphic organizers produce greater effects than pre graphic organizers and students' involvements in graphic organizers enhance the effects.

Robinson and Katayama (1998) conducted 2 experiments to investigate the effects of review occasion and study materials on students' application of concepts. Experiment 2 (n = 110) was to replicate experiment 1 (n = 88) and to ensure the reliability. Subjects were students who enrolled in an undergraduate educational psychology course. There were 3 set of learning materials, text plus graphic organizers, text plus outlines, and text only; and 2 review occasion, immediate and delayed (for 2 days). The concept in the learning materials is *abnormal behavior*. The results show that the effects of study materials in immediate groups are not significant, but the group of delayed and text plus graphic organizers scored significantly higher than the group of immediate and text plus graphic organizers. The results consist with the results in Moore and Readence (1984). Robinson and Katayama (1998) recommend to present graphic organizers to students a few days after the materials have been read.

Griffin and Malone (1995) conducted a study to examine the effects of graphic organizers in comprehension, recall and transfer of information in an expository textbook and the degree of necessary for use of graphic organizers. Five intact classes of fifth-grade students from two elementary school participated in the experiment. The reading materials are all subsections of chapter 22, “Canada”, from the book of *United States and Its Neighbors* published by Silver Burdett Co. in 1984. Total of 99 subjects were randomly assigned to one of five groups, explicit graphic organizer, explicit instruction without graphic organizer, implicit graphic organizer, implicit instruction without graphic organizer, and traditional basal instruction. Three types of measurements, immediate and delayed posttests, immediate and delayed recall tests, and a transfer test were administrated. Results show that the performance of students in graphic organizer groups was statistically higher on the transfer measure than students in traditional instruction condition.

In a meta-analysis of graphic organizers and students with learning disabilities, Dexter and Hughes (2011) conclude that graphic organizers “are not only improving basic skills (e.g., factual recall) but also higher-level skills (e.g., inference)” (p. 67). Other research in applying graphic organizers to students with learning disabilities in different subjects have the similar results (DiCecco & Gleason, 2002; Bob Ives, 2007; B. Ives & Hoy, 2003). Therefore graphic organizers could be more effective on students with lower cognitive capability, and information organizing capability.

When to Use Graphic Organizers

Table 4.2

Conditions of using graphic organizers

	Conditions
Learning context	• Learning materials contain expository text
	• Target concepts have strong relationships with other concepts
Learning goal	• Meaningful learning
	• Knowledge transfer
Learner	• Learners are lack of capabilities of organizing information
	• Learners with learning disabilities
Learning task	• Declarative knowledge
	• Concept
	• Procedure/Principle

Graphic organizers could be used in concept learning. Rob Foshay (2003) argues that a concept is a group of things, which have some features in common. The concept is related to other concepts in several ways (coordinate, subordinate, or superordinate), and has a prototypical example. Concept learning needs all these information to fit together into a knowledge structure. Graphic organizer could be used to organize the information that is related to a concept.

Graphic organizers could be used in reading comprehension. Expository text is to inform or describe facts. Typically, an expository text has logical structures. Graphic organizers could be used to represent the main ideas or facts within the text more apparently .

Graphic organizers could be more effective when they are presented after instruction, especially when learners are involved to construct the graphic organizers.

Graphic organizers could be more effective on students with lower learning skills, especially for students who lack skills for organizing written information, and understanding relationships and connections.

How to Use Graphic Organizers

The process of using graphic organizers includes analyzing learning tasks, designing graphic organizers, developing graphic organizers, implementing, evaluating, and revise (figure 4.1).

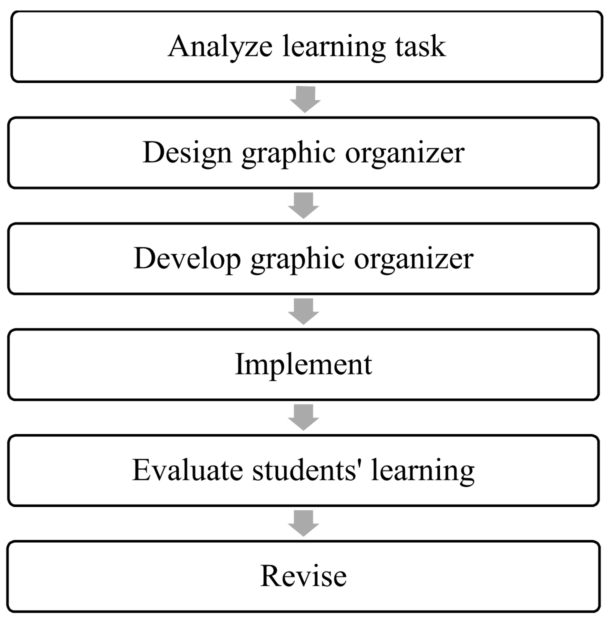


Figure 4.1. The process of using graphic organizer

First, you have to identify the type of the learning task. Is it a concept, a series of events, or a procedure? Then, you need to design graphic organizers for the learning task. You can use table 3.1 to decide what kind of graphic organizers will be appropriate for your situation. For examples, if it's a concept, you can design a venn diagram for comparison and contrast, or design a web to list all the characteristics of the concept; if it's a series of historical events, you can design a timeline to represent the sequence of events and discover possible patterns in these events; if it's a procedure, you can use a flow chart to descript the steps. Next, you will develop the graphic organizers. You can use paper and pencil or use computer software to develop graphic organizers. For most of tables and charts, you can use Microsoft Office, or Open Office tools. Some free online tools are also possible for particular types of organizers, for example, Popplets (http://www.popplets.com) for web structured organizers; Timetoast (http://www.timetoast.com) for timeline organizer. After you develop the graphic organizers, you can substitute empty placeholder for some certain words or ideas in order to promote students' participations.

Implementing graphic organizers includes decisions on when to distribute the organizers and how learners can participate. Graphic organizers can be distributed to learners before, during, or after instruction. Although researchers suggests that post graphic organizers are more effective, the time distribution depends on different learning context and the purpose of graphic organizers. If you use graphic organizers to help students take notes, it will be better to have students use the graphic organizers during the instruction. Another example is advance organizer, which can be implemented using graphic organizer. Advance organizer is to help the learner organize and interpret new incoming information (Mayer, 2008), so it would be distributed before the instruction.

Evaluating is required if learners are asked to participate in constructing graphic organizers. The learner's graphic organizer can be personalized and subjective, but comparing the learner's work with peers' or experts' works can provide additional information from different perspectives for the learner.

Summary

This chapter introduced graphic organizer strategy in instruction. We discussed what is organizer strategy, theories and research about graphic organizer, when and how to use graphic organizer. Graphic organizer strategy can be used on expository text when the learner is lacking capabilities to organize information. The process of using questioning includes analyzing learning tasks, designing graphic organizers, developing graphic organizers, implementing, evaluating, and revise.

Exercises

1. Choose an expository text. Analyze the text and determine your learning tasks. List at least three graphic organizers that could be appropriate for the learning tasks. Explain why you choose them.
2. Select the most appropriate graphic organizer and design yours for the learning tasks in exercise 1. You also can choose to create your adopted or customized graphic organizer. Explain why you design the graphic organizer in this way?
3. Describe how you will implement the graphic organizer(s) in exercise 2.

Chapter 5 Problem-Based Learning

> You can memorize your way through a labyrinth if it is simple enough and you have the time and urge to escape.
>
> But the learning is of no use for the next time when the exit will be different placed.
>
> — Unknown

Objectives

- To develop PBL problems for instruction
- To develop specific assessment for PBL
- To apply PBL in instruction

Instruction

Students who are studying in a fundamental computer networking course complains that they cannot apply the knowledge and skills into real world problems. They have learned about network topology, network protocols, network devices, and network addressing, and they have completed all the exercises provided by the instructor. However, they cannot solve problems in real situations.

Now, based on previous situation, try to answer following questions from the perspective of an instructional designer:

1. What do you know?

2. What do you need to know?
3. What would you like to do now?

In this example, I try to use a Problem-Based Learning (PBL) approach to introduce PBL. The problem here is that students cannot apply their knowledge, which means students can memorize the concepts and rules but cannot transfer these learning into new problems. To solve this problem, you need to get facts (what facts in the problem), then raise your own questions and learning issues, and propose possible solution(s) at last. This chapter introduces the PBL approach, what is PBL, theories and research about PBL, and when and how to use PBL.

What is Problem-Base Learning

PBL is an instructional method based on a principle of learning is initiated by problem that the learner wants to solve (Duch, Groh, & Allen, 2001). PBL is originated in medical education. In PBL, groups of students are presented by complex, real-world problems to "identify and research the concepts and principles they need to know to work through those problems" (Duch et al., 2001). The process of PBL is shown in figure 5.1

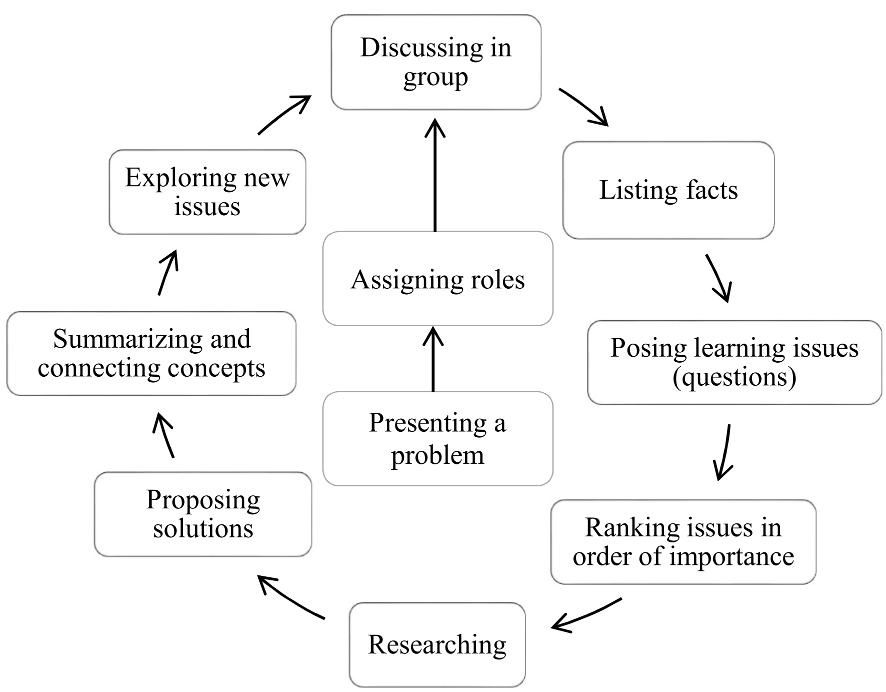


Figure 5.1. The cycle of PBL (adapted from Duch et al., 2001, pp. 6-7; Lambros, 2004, pp. 2-3)

The core design of PBL is problem. Not all problems are effective PBL problem. Here is an example of problem: "You are in the course of instructional design. Your instructor has explained why learner analysis and learning tasks analysis are important. You need to understand your leaners' characteristics and the type of learning tasks before you analyze them…" Is this an effective PBL problem?

Before you give your answer, let's check the five important characteristics of a good PBL problem (Duch, 2001). The first characteristic of a good PBL problem is to engage students' motivation. The problem should attain learners' attention, be relevant to leaners, and be challenging and reachable.

The second characteristic is to let learners make decision. Information in a problem could be irrelevant, or could not be enough to a solution, just like a real-world situation. Learners must decide what information is needed. Some problems could be presented within multiple-stages. Learners need to ask right questions to get more information in later stages.

The third characteristic of a good problem is complexity. The problem should be challenging enough for cooperative learning. Learners must work as a group rather than individually. Duch (2001) indicates that the complexity would let student realize that a "divide and conquer" strategy wouldn't be an effective problem-solving strategy.

The fourth characteristic is to set the initial questions to be open-ended and be controversial. This also can keep groups working together.

The fifth characteristic is that PBL problems should include the objectives of the course. Duch (2001) states that "[the] problem's questions should challenge students to develop higher-order thinking skills…, where they analyze, synthesize, and evaluate" (Duch, 2001, p. 49).

According to the five characteristics of a good PBL problem, the problem we presented previously is not a genuine PBL problem. In the exercises at the end of this chapter, you have the opportunity to convert this problem to be an effective PBL problem.

Research: Does Problem-Base Learning Works?

Gabr and Mohamed (2011) conducted a research to examine the hypothesis that the knowledge score, self-directed learning, and problem solving score of nursing students learned by PBL are significantly higher than those learned by lecture method. The subjects were a group of junior nursing students at the nursing administration department (n = 374). These subjects were divided into a study group, which used PBL strategy, and a control group, which used traditional lecture strategy. The results show that study group's knowledge score, problem solving skills, and self-directed learning are significantly different. Gabr and Mohamed (2011) conclude that "PBL is a potentially powerful approach for students to gain practical problem-solving experience and self-directed learning" (Gabr & Mohamed, 2011, p. 154)

When to Use Problem-Base Learning

Table 5.1

Conditions of using problem-based learning

	Conditions
Learning context	• Learning tasks contain complex, higher level problems for application in real world.
Learning goal	• Learners can solve problems in real situation
Learner	• Learners have or familiar with prior knowledge of concepts,

	principles, and procedures in the domain of the problems
Learning task	• Problem solving

How to Use Problem-Based Learning

The process of using problem-based learning includes analyzing learning task and identify target problem, creating a story line, implementing, evaluate students' learning, and revise.

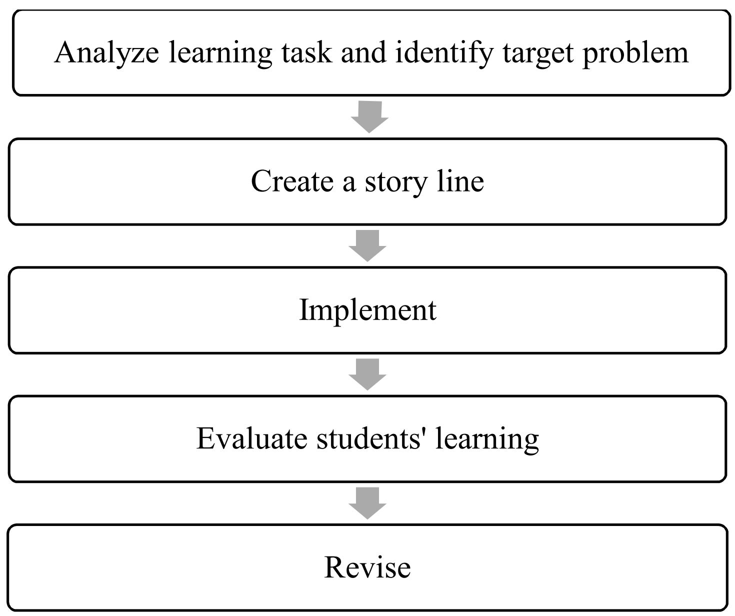


Figure 5.2. The process of using PBL

Analyze learning task and identify target problem. You should analyze the learning tasks thoughtfully and identify which tasks are needed to be included into the PBL activity. These learning tasks should be turned into learning issues by the students (Lambros, 2004). After that, you could define your target problem.

Create a story line. Create a story that makes students feel like they are in a real situation. For example, you can describe the problem begins with the words "You are …", so you can put students in the role of your story. After you finished your story, check whether the story has included necessary factors to solve the problem. As we discussed previously, information could be irrelevant, or could not be enough to a solution, just like a real-world situation. However, the information should be enough to generate learning issues, which required for the learning tasks.

Implement. In PBL, students are present with a problem first; then, students could collect factors in the problem and pose their own questions (learning issues); after that, students could make a plan and assign tasks for each group member; next, students could list possible solutions and generate new issues; finally, students could conclude their solution(s). Table 5.2 could be used in PBL activity to record information.

Table 5.2

PBL Process (Retrieved from Lambros, 2004, p. 11. Reproduction is authorized for local school site that has purchaxed the book)

<table>
<tr><td colspan="2">Facts</td><td colspan="2">Need to Know</td><td colspan="2">Leaning Issues</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="3">Possible Solutions</td><td colspan="3">New Learning Issues</td></tr>
<tr><td colspan="3"></td><td colspan="3"></td></tr>
<tr><td colspan="6">Defendable Solution(s)</td></tr>
<tr><td colspan="6"></td></tr>
</table>

Evaluate students' learning. Evaluate students' PBL activities is more complex than the previous four strategies. Assessment rubrics should be prepared for both group and individual students in the group.

Revise. Based on the formative evaluation of the whole instruction, you can revise the worked example strategy comprehensively with other parts of the instruction.

Summary

This chapter introduced PBL in instruction. We discussed what is PBL, theories and research about PBL, when and how to use PBL in instruction. The process of using problem-based learning includes analyzing learning task and identify target problem, creating a story line, implementing, evaluate students' learning, and revise. PBL is often implemented with cooperative learning, and assessment of PBL should be at both group level and individual level.

Exercises

Convert the problem on page 37 to a good PBL problem. Explain why you do in this way. You need to include assessment plan as well. The original problem description is:

> You are in the course of instructional design. Your instructor assigned a topic for you and has explained why learner analysis and learning tasks analysis are important. You need to understand your leaners' characteristics and the type of learning tasks before you analyze them…

Final Project

Design and develop an instruction using at least two strategies introduced in this training manual. You need to choose a topic and identify your target learners. The instruction needs at least one hour but no longer than two hours to be finished. You need to include learning goal, learning objectives, instructional strategies, activities and practices, and assessment. The instruction could be any media format, but you need to prepare a paper that discussing your design principles.

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Appendix A

Table 1.

The conditions of using different strategies

Strategy	Learning Context	Learning Goal	Learner	Learning Task
Analogy	• Original learning materials are using abstract literal depiction techniques for concepts • Time limitation. There is no extra time to develop sophisticated visual representation of concepts.	• Meaningful learning. Learners need to understand the concept meaningfully and can apply in higher-level skills	• Learners are lack of background in new learning domain	• Declarative knowledge • Concept
Questioning	• Learners need to get focus • Need to check learners' understanding • Better to use with discussion	• Learning for test and for mastery	Not specified	• Concept • Procedure/Principle • Problem solving

Strategy	Learning Context	Learning Goal	Learner	Learning Task
Worked-Out Example	• Faster learning	• Better transfer • Less cognitive load	• Learners with higher or lower level of prior knowledge	• Procedure • Problem solving
Graphic Organizer	• Learning materials contain expository text • Target concepts have strong relationships with other concepts	• Meaningful learning • Knowledge transfer	• Learners are lack of capabilities of organizing information • Learners with learning disabilities	• Declarative knowledge • Concept • Procedure/Principle
Problem-Based Learning	• Learning tasks contain complex, higher level problems for application in real world.	• Learners can solve problems in real situation	• Learners have or familiar with prior knowledge of concepts, principles, and procedures in the domain of the problems	• Problem solving