eラーニング・ファンダメンタル
eLearning Fundamental

Chapter 9 Designing learning support in e-Learning

Learning Objectives:

Be able to analyze learning support design of an existing e-Learning material based on Gagné's nine events of instruction and to propose improvement.

Be able to analyze an existing e-Learning material from the three theoretical perspectives (behaviorism, cognitivism, constructivism) and as to how they are applied to learning support design.

Summary of this Chapter

- Learning support design in e-Learning can be viewed as having three components: providing information, interaction, and links
- Gagné's nine events of instruction are nine kinds of support to facilitate the learning process, proposed on the basis of cognitive psychology and are widely known as a basic framework for instructional designers.
- Gagné's nine events of instruction propose appropriate instruction strategies for each of five types of learning tasks that require different learning conditions. Relevant research results are integrated in it, such as an advanced organizer for verbal information learning and learning by observation for attitude learning.
- Learning support based on behaviorism includes drill-and-practice type material. As a control mechanism of practice cycle of a drill, one must design selection of items to be included in the drill, evaluation criterion for measuring achievement of learning objective, a mechanism to select or remove items, form of practice and type of response, and method to give feedback.
- As learning support based on constructivism, a design guideline of flexible learning environment has been formulated focusing on collaborative learning, approaches from multiple perspectives, and authentic context.
- Eclecticism is an approach to solve a problem by combining theoretical perspectives. A framework is proposed based on eclecticism to utilize creatively ideas from Behaviorism, Cognitivism and Constructivism.

Section 1 Designing learning support in e-Learning: three components

If providing information were enough to achieve learning outcomes, instructional designers would have an easy job. Just as everyone would listen intently to Bill Gates or Alan Kay speak (at least once!?), in the e-Learning environment you provide, everyone absorbs and understands information you provide as "a sponge soaking up liquid." Do not expect that. Although e-Learning is based on an assumption of proactive attitude of learners, if no effort is made to make learning easier, one cannot say that good e-Learning is provided. Thus, learning support design is required.

Learning support design is considered a major issue of ID, and a number of ID models and theories have been proposed to date. Before introducing them, let me present the simplest and most effective framework. It is to consider learning support design in e-Learning based on the three elements, which are providing information, interaction, and links (Ingram & Hathorn, 2003). Figure 9-1 shows an example of how to design the three elements, taking organizational culture as learning content. By creating a table in a similar way for each e-Learning case, you can start to design learning support. Figure 9-2 indicates types of interactions on the Web. It would be better to consider what can be possible, in connection with the example of organizational culture.

Figure 9-1: Example of learning support design: organizational culture (Ingram & Hathorn, 2003)

Learning objective	Providing information	Interaction	Link
Understanding what organizational culture is and why it is important	• Specify chapter in textbooks • Online lectures on organizational culture • Exhibit references	Turning the pages is required in the online lectures Take quizzes at the end	Links to articles on cultures in companies Links to Hot Potatoes to take the quiz
Acknowledging major indicators on aspects of cultures in companies	Cover all factors to be viewed when visiting companies or companies' websites	By visiting companies' websites, create a report on the points that attracted attention	Links to companies that have unique organizational culture Links to Hot Potatoes to take the quiz
Evaluating the importance of matching between organization culture and human resources who join the organization	Definition of suitability between the human resources and the organization/ learners propose to each other a variety of matters on the suitability between human resources and organizations/ propose concrete examples to learners	Work on tasks in groups using discussion board with threads: present the result produced by each group	Promote asynchronous participation also by using discussion board function Receive advice by e-mails from instructors

Note: Table 5 (p. 55), by Ingram & Hathorn, 2003. There are many doubts in the examples, such as why just turning pages can be regarded as interaction and why using discussion board and e-mails just among themselves can be considered "links"; however, by intention, everything is shown just as it is written. They are understandable, though. Especially, the author likes that providing information does not depend on online only: They use a textbook, too.

Figure 9-2: Types of interactions on the Web (Ingram & Hathorn, 2003)

Interaction	What is this?	When to use
Investigative activities	Letting the learners click the related links allows them to conduct investigative activities. It is possible to create links not only to words but also to images or flowcharts, combining with clickable image map.	Introduction to a new area; proposing machine to operate or working processes.
Quiz	Give learners objective questions (multiple choice, matching, filling blanks), which are immediately scored by computers. The scoring results are given to the learners as feedback, but are not given to managers and instructors.	Utilize as a self evaluation to guide learning. Enhance learning concepts or skills.
Online test	A number of objective questions and constructive questions. Instructors are required to score constructive questions. The results are given back to the instructors.	Evaluation. Utilize as an indicator of the instructors' work. Utilize for qualification.
Tutorial (individual instruction)	Learning with complicated subject on a step-by-step basis, with providing information and presenting short questions.	Teaching clearly defined contents.
Case study	Long article to introduce an actual situation. Let the learners choose which information to read.	Teaching high-order intellectual skills, such as problem solving.
Homework	Let learners submit any type of homework, such as computerized or paper-based ones, through the Web. Feedback for them is provided from the instructors	Dealing with a number of different high-order intellectual skills.
Discussion	Most of discussions on the Web are asynchronous, but synchronous discussions are increasing recently. Used for letting learners discuss a certain concept or solve problems cooperatively, as well as interaction with instructors	Devising ideas, learning knowledge and/or skills from each other.

Note: from Table 2 (p. 52) by Ingram & Hathorn, 2003

Section 2 Gagné's nine events of instruction: ID theory supporting the learning process

Robert M. Gagné is a prominent learning psychologist known as a "Godfather of ID," in the field related to educational technology. After competent research activities over more than 50 years, he passed away in 2002 as a professor emeritus of Florida State University. For me, personaly, Professor Gagné was the instructor in his class "Foundations of instructional theory" and his special topic course "Schema theory and instructional design," while I was studying at Florida Sate University. At my request, he also served as a member of my dissertation committee when I got my Ph.D. I recall that he was a large man with sharp eyes and had great enthusiasm for research even in his later years, and he always answered my insistent questions carefully, when I visited his office.

Gagné's ID theory has been introduced to Japan from early on; for example, the Japanese edition of "The Conditions of Learning (1st Ed.)" was published in 1968. People who know Gagné's theory from a long time ago tend to label it "traditional theory (old-fashioned)" derived from behaviorist psychology represented by Skinner. However, the concept that has supported the formation of Gagné's theory consistently was indeed an attitude to adopt

relevant research results without adhering to any specific theoretical camp. It is called "eclecticism," transcending any popular theoretical trends of the time. Gagné's nine events of instruction is the most widely-known ID theory, established from his viewpoint of focusing on applying research in learning psychology to the design of instruction. It is a framework for designing instruction in general, which can also be applied to the design of e-Learning materials. A summary of Gagné's nine events of instruction according to Suzuki (1995) is shown below.

Photo: at the completion of doctoral dissertation defense (March, 1987)
Professor Gagné at to the author's right, My major professor Wager is at the left

Gagné posits instruction process as "an attempt to support the internal learning process externally (external condition)." Thus, learning can be facilitated by constructing instructional material and training, through creative means for explanation and practices. It is advised to reflect the learning model that explains how humans acquire new knowledge or skills. Further, by analyzing the process of good teaching practices in terms of how they support the learning process, one can see the point that made the teaching excellent. He organized learning support design taking from both theories and practices and proposed that categorizing them into nine types is effective; thus, named it the nine events of instruction (Figure 9-3).

The prominent behavioral psychologist B. F. Skinner was astonished to see his daughter's teacher's everlasting explanation and his daughter just passively listening to it when he visited her class. Thinking that "it is not effective learning, I want to realize a learning environment where the learners actively respond and they are provided with immediate feedbacks," he posited program learning and teaching machines as the learning environment that reflected psychological achievement in those days. He had much influence on the educational world. This method proposed not only "explanation by teachers," but also "letting learners actively solve tasks" and "providing learners immediate feedback (reinforcement/incentive). This proposal is still effective now after the behavioral psychology boom was over.

However, the nine events of instruction that Gagné proposes are not limited to active reaction and feedback. The reason is that Gagné's proposal is based on the information process model of learning that aims to elucidate the mechanism of learning by modeling the process of internal information process of the human. It is different from Skinner's behavioral psychology, which posited the human as a black box without treating what is happening inside the body as the subject of the research.

Figure 9-3 Gagné's nine events of instruction and its applications

Nine events	Example: Mathematics "measuring the area of a rectangle"
1. Get learner's attention	Show two comic books which differ in both length and width, and ask which is larger than the other
2. Inform learner of the objective	Let the learners be aware that both of the comic books are rectangular and notify them that the task of the day is how to measure the size of a rectangle
3. Recall entry condition	Confirm that the opposite sides of a rectangle are parallel to each other and its corners are right angles. Remind the learners of the calculation method to measure a square learned in the previous class.
4. Present new information	Indicate the formula to calculate the area of a rectangle (square measure = height x length) and show some examples to apply it.
5. Provide learning guidance	Let the learners compare the formula to calculate the size of a square and rectangle and think what is different. Encourage them to use the formula by paying attention to both points of similarity and difference.
6. Give opportunities to practice	Let the learners calculate the size of some rectangles by themselves that differ in height and length, using numbers that were not used in the previous examples.
7. Provide feedback	Write the correct answer on the board and let the learners check their answers. For the learners who obtained a wrong answer, indicate the reason why they obtained the wrong answer, depending on the types of their mistakes.
8. Assess learning outcome	Check the level of achievement by a simple test, and take measures for the learners who do not obtain good results. As well, take the measures as a reference for the next lesson.
9. Enhance retention and transfer	Confirm how to measure the area of a rectangle when it may be forgotten. Let the learners think of how to measure a parallelogram and trapezoid.

9-2-1: Introduction: preparation to start new learning

Generally, "introduction" provided at the beginning of the training is intended to prepare for starting learning new things. According to Gagné, the introduction has functions of attracting the learner's attention to the instruction, notifying them of the learning objective, and reminding them of necessary items among what they have already learned (from the Event 1 to Event 3).

In the information process model of learning, the learners are not regarded as passive entities who only respond when they are stimulated externally. They are rather regarded as "active processors of information" who are always actively choosing what they want from the environment, interpreting it based on the relationship with what they have already known, widening their knowledge, and acquiring skills. Therefore, the learners assembled in the class are always actively using their five senses to learn various kinds of things, which may or may not something related to the topic of instruction. In the introduction, then, active intellectual activity must be converged into the main course of instruction, and the information-processing activity of each learner must be maintained.

First of all, in order for the message from the instructor to reach the antenna of the learners, the frequency of signal must be adjusted to the learners' interest (Event 1: Getting learner's the attention). After the adjustment, propose the goal to achieve and focus the learner's information processing activities to the objective (Event 2: Informing the learners of the learning objectives). By proposing the learning objective and notifying the learners of its meaning from the beginning, raise the motivation to learn and let them have expectations, and also aim for further activation of the work in their brains.

The last function of the introduction is to remind basic knowledge and skills stored in the long-term memory (Event 3: Recall entry condition). In the name of a review of the previous lessons, reviewing the contents that are not related to the day's study does not serve as the introduction. In order to connect the new learning with their existing knowledge, experience, and skills that have already been learned, the related basic knowledge and skills have to be taken out from storage, but not unrelated ones. In the background of this, there is cognitive model human learning that hypothesizes short-term and long-term memories. Short-term (working) memory in the brain processes and modifies new information, whereas long-term memory stores what is learned. Short-term memory's capacity is limited; at any given time, it can deal with only seven items plus/minus two, thus only necessary information should be retrieved from the long-term memory, just in time for the new learning.

9-2-2: Presenting new information and learning activity: making the new item as a part of your own knowledge

After the introduction comes the main part, which is considered to support two major tasks; to combine the new information into the memory net, and to create the path for extracting the new information that has already been stored.

The new contents are provided (Event 4: Presenting new information) while highlighting the difference from, the similarities with, and relationships with those items that have already been learned, which were extracted in the introduction (Event 3). In addition, rather than just providing the items, provide the learners with advice to help understanding the items in a meaningful form (Event 5: Provide learning guidance). Experience has shown that things that are just memorized are easily forgotten, and if one knows why the things are so, they remain in one's memory for a long time. This is supported by the model that the human memory is in the form of a semantic network with meanings, and a thing that has a number of connections with other items can remain in the network, and thus be memorized for a long time (stored in long-term memory storage).

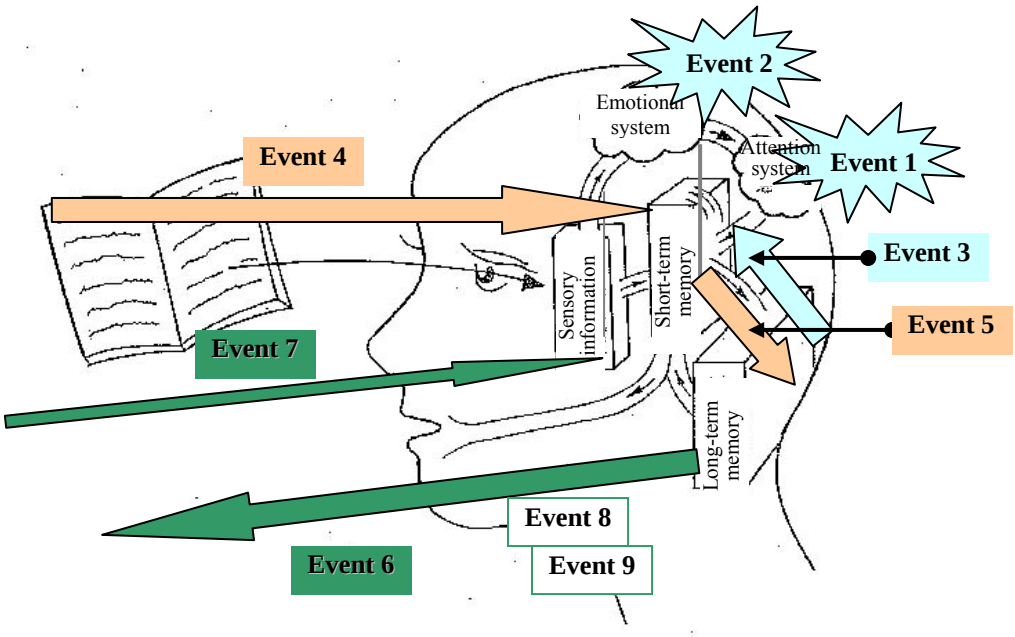

Figure 9-4: Human information process model and the nine events of instruction

To confirm that the new items are stored in long-term memory, give opportunities for each of the learners to extract the information or apply the skill (Event 6: Give opportunities to practice). By only listening to explanation of the instructor or collecting various kinds of information, one cannot know for sure whether or not it has actually been acquired. The status of the practice is to be provided as feedback to the learners so that the acquisition is gradually completed (Event 7: Provide feedback). As the background that these two events are regarded important, there is the notion of response-feedback-reinforcement form behaviorist psychology. But, not only that, there is the goal to memorize the method to reminding oneself what was learned, while practicing for retrieving the new items from the long-term memory. As things are frequently learned from failures, it is essential to prepare an environment where one can feel safe to fail during the practice. Therefore, the achievement record of practices should not be included as a factor for grading. It should rather be utilized as an opportunity to teach why the responses are incorrect and how to make it right, welcoming failures.

9-2-3: Summary = Confirm the achievement and make it unforgettable

The evaluation is considered to be done separately from practices, and the evaluation itself is an attempt to encourage learning (Event 8: Evaluate learning result). In order to confirm if the new items are surely acquired, give a test after providing sufficient opportunities to practice. Let the learners take the test under the tension that no mistake is allowed this time, unlike in the practice, making it an opportunity for the learners to experience the achievement of learning. Considering the reality that no one studies unless a test is to be given, we all know that this event is very helpful for learning.

In the end, opportunities to review or for advanced learning should be given so that the achievement of learning lasts long and the learners can apply it for learning other items (Event 9: Enhance retention and transfer). Because it is better to give the opportunity to review when the learners have forgotten the items; this event does not necessarily have to immediately follow Events 1 to 8. If the learners see the information in textbooks, whether they remember it or not becomes unclear; therefore, the review must start with letting the learners answer questions (just like in Event 6). By being conscious of having opportunities to apply what they have learned, the learners discover the connection between the learning in the future and current learning, and the network of meaning in their brain will be enhanced. Consider how to utilize the current learning achievement and being conscious of having opportunities to apply what has been learned, to accomplish one of the functions of the last event, “increase transfer.”

Figure 9-5 provides tips based on Gagné’s nine events of instruction. Although Gagné’s nine events of instruction indicate a basic learning process based on the information process model of learning, they do not assert that the training should be constructed exactly in this order; some training may start from Event 8 for assessing prior learning, for example. They do not assert that all of the nine events should be provided in one lesson; they can be provided in a series of lessons to make a longer set of events. They can be used as a framework to review the meaning of each element from the viewpoint of “supporting learning” by reviewing the structure of learning support design based on the learning process.

When an event is not provided by the instructors, the learners themselves have to provide it in order to ensure the learning. In stead of trying to provide everything from the instructor, it may be better to tell the learners to advance their learning by themselves. Teach the learners how to complement the events that for various reasons would not be included in the training.

Advancing the learning based on the framework of Gagné's nine events of instruction on their own leads to development of self-learning ability (learning skill). To learn how to learn can be viewed as to become able to prepare the external conditions to support their own learning. Nine events of instruction can be utilized to foster self-learning ability to learn how to learn to be an independent learner.

Figure 9-5: Strategy to support the learning process
– tips based on Gagné's nine events of instruction

Introduction: Prepare for learning new things

1. **Gain learner's attention >> Create conditions to receive information**
   - ■ Start the class with something strange or unusual, or make a sudden change to open the learner's eyes wide
   - ■ Seek something fresh every time so that the learners do not consider this to be the start of a boring class.
   - ■ Use questions, contradictions, or facts that overturn the learners' knowledge so as to stimulate their intellectual curiosity, letting them wonder "Why?"
   - ■ Suddenly start with something fun, such as an anecdote, tidbit, or something that gets to the core of the matter
2. **Inform learner of the objective >> Stimulate the brain and let them focus on important information**
   - ■ So as not to spend the time absent-mindedly, clarify "we will learn this today" at the beginning
   - ■ Surprisingly, what is to be learned is often not grasped. First of all, make a contract on what to teach/learn
   - ■ Use words that are easy to understand so that what to learn today is clearly conveyed to the learners
   - ■ Identify the points that they should pay attention to or listen to carefully
   - ■ Check the future benefit of what to learn today and help the learner find the value in the objective
   - ■ Confirm the goal so that, upon arriving at the goal, they can quickly understand that they have reached it and feel delighted
3. **Recall entry condition >> Review related items that were learned before**
   - ■ Review basic items necessary for starting new learning successfully and refresh their memories
   - ■ Clarify how what to learn today is connected with what has been learned
   - ■ While thinking that what was learned before has been forgotten as a matter of course, prepare methods to confirm them again
   - ■ Be creative in using quizzes to review, brief explanations, and/or questions

Figure 9-5: Strategy to support learning process
– tips based on Gagné's nine events of instruction (continued)

Present information: introduce to the new item

4. Present new information >> Concretely present what is to be learned

- Propose/obtain what is to be learned today in a organized style to show/confirm a good example
- Use not only abstract information (a formula and name of concept) but also plenty of concrete examples
- Select/create examples that learners find easy to understand, or easy to explain in their own words
- First present a typical and relatively simple example, then gradually shift to special or exceptional examples
- Creatively use figures, tables, or illustrations so that it becomes easy to get the whole picture and understand differences among examples

5. Provide learning guidance >> put what is new into the brain in a meaningful form

- Put the new items into the brain by highlighting the relationship with what has been learned and connecting with them
- Use everything that can be used, such as comparison with what is well known, parables, and metaphors
- Think of hints for reminding and memorize the usage of the hints

Learning activity: acquiring new item as one's own

6. Give opportunities to practice >> practice taking it out from the brain

- In order to find the weak point by oneself, have enough preliminary practice under the condition that failure is allowed before actually doing it
- Check how much one can actually do it by doing it without looking at worked examples
- Initially use partially worked examples or easy tasks, then gradually make them more difficult
- If the objective is application of a skill, let learners try different examples

7. Provide feedback >> recognize learning status and overcome weak points

- In order to learn from failures, seek the source of the failure, why it led to failure, and how it can be improved
- Ensure the security that failure does not cause any disadvantage, and avoid words that accuse the learner of failure
- Praise learners if they have succeeded, and give advice if they have failed (how to attain the objective)

Figure 9-5: Strategy to support learning process
– tips based on Gagné's nine events of instruction (continued)

Summary: Confirm the achievement and make it unforgettable

8. Evaluate learning result >> confirm the achievement and feel the accomplishment

- ■ As an "actual performance" to assess the learning achievement, give a test after giving enough opportunities to practice
- ■ Prepare a sufficient amount and range of questions to ensure that the objective has really been achieved
- ■ Ensure that evaluation is appropriate for the objective and consistent (do not test what is not to be taught)

9. Enhance retention and transfer >> make the achievement last long and thoroughly enough for application

- ■ After time passes, it is natural to forget what one had once been able to do. Plan an activity for reviewing when the learners may forget it
- ■ During review, do practices without seeing examples or letting them prepare, in order to check whether the learners are still capable
- ■ Seek the situation where what the learners have been able to do once can be applied to connect to the next learning
- ■ Prepare advanced learning on the achieved objective to deepen the learning beyond the objective

Source: Katsuaki Suzuki (1995)" Premier of instructional design from Educational Broadcasts", Japan Association for Educational Broadcast, pp. 52-53

Note: This part of this Chapter is a reprint of Chapter 2, Suzuki (1995), with partial modification.

Section 3 Five categories of learning outcomes and instruction strategy

The second main framework of Gagné's ID theory is the five categories of learning outcomes (refer to Chapter 3). It provides ways to think about how to realize events of instruction according to the characteristics of learning objective.

The method of categorizing learning objectives proposed by Gagné is based NOT on the difficulty levels of the learning tasks, but on the differences of the natures of learning outcomes (as a framework for categorizing based on difficulty level of learning tasks by cognitive, affective, and motor domain, Bloom's taxonomy is widely known). Focusing on the differences among necessary conditions to facilitate learning, it proposes a framework of category based on the differences of preparation necessary for the learners (internal conditions) and differences among the method of effective learning support as external conditions. Therefore, by categorizing learning objectives according to Gagné's classification, one can obtain hints for instructional strategy appropriate for the characteristics of the objective. Figure 9-6 lists them.

Figure 9-6: Gagné's five learning outcomes and principles of learning support design

Learning outcome	Verbal information	Intellectual information	Cognitive strategy	Motor skills	Attitude
Nature of achievement	Memorize specified items Declarative knowledge Reproductive knowledge	Ability to apply rules to new examples Procedural knowledge	Ability to increase effectiveness of one's own learning process Learning skill	Ability to move/control muscles of the body	Mind-set to choose/avoid a certain thing or situation
Capability verb that indicates category of learning (Event 2)	Describe	Identify Confirm Categorize Illustrate Generate	Adopt	Execute	Select
Evaluation of achievement (Event 8)	Recognize or reproduce the information that is presented in advance Test all of the items or random extraction	Apply to new examples rather than reproduce the rule itself Give questions from all of the types of tasks, to confirm the range over which one can apply the rule	Apply the process of learning rather than the result Observe the process of learning or use self-description report	Perform it: the knowledge how to do and ability to carry it out are different Utilize lists and check precision, speed, and smoothness	Prepare the scene to observe action or expression of intention to act. Deal with personal choice behavior, not in general terms
Entry condition (Event 3)	Recall well-learned, related information and its framework	Recall lower-level basic skills that are the entry condition of the new skills	Recall similar, learned strategies and related intellectual skills	Recall learned partial skill or more basic skills	Recall the content of choice behavior, and information of the scene
Present the content (event 4)	Present all of the new information categorized by similarity or characteristics	Present new rules and application examples by increasing levels of difficulty, on a step-by-step basis	Explain effects of the new strategy using examples	Explain the situation where the new skill is to be used, then show some examples	Human model actually performs and explains choice behavior and its consequences
Learning guidance (event 5)	Pun, metaphor, images, and positioning in the framework	Various types of application examples, keys to recall the rule, and indication of portions that are often failed	Application example in other situations, how to identify the situation where the strategy is to be applied	Indication of where attention should be paid, explanation of the differences between successful and failed examples. Image training	Explanation on the importance of choice behavior, introduction of the trends of other people or public opinions
Practice and feedback (Event 6,7)	Recongnize with hints, then practice to reproduce. Organize them into one's own framework. Removal of the acquired item and focus on the practice of unacquired items	First simple and basic examples, then complicated and exceptional examples. Always use new examples. Review lower-level skills depending on the cause of the mistake	Long-term practice in the order of forced application using similar examples, voluntary application, and unconscious application. Confirm through working on other learning tasks	First supported exercise considering the procedure, then independent exercise. After acquiring all of the procedure, repeat practice to improve speed or timing	Simulated chosen behavior (if it was you) and simulated experience by the information of consequence of alternatives. Rattle and deepening by exchanging opinions

Source: Katsuaki Suzuki (1995) " Premier to instructional design from Educational Broadcasts" Japan Association for Educational Broadcast.

9-3-1: Learning condition of intellectual skills

Intellectual skills are learning tasks to apply what has been learned, such as rules, to unlearned examples. Different from learning to memorize and recalling a formula or definition (which is categorized as verbal information), it can be acquired through applying a skill to a new example. Do not reuse examples used in explanation and do not reuse examples used in practices in tests, in order to avoid the situation where learners can complete the task as a result of memorizing the answer. Intellectual skills can only be regarded as being gained when learners successfully apply them to a new example.

Mathematics is considered to require not only memorizing formulas but also skills to properly utilize the acquired formulas in a situation that requires them (thus, it consists of intellectual skills). However, in so-called mathematics for entrance examination, it is said "mathematics is memorization (thus, it is verbal information)", where learners are forced to memorize the patterns of problems in order to reach the answer within the limited time. There is no time to think after reading the problems in order to ensure solving them within the given time. In that case, memorizing the pattern of the problems is categorized as verbal information, leaving only the calculation process performed in the recalled pattern as including factors of intellectual skills. This is a bad example of a learning task distorted by test conditions.

The entry condition of learning intellectual skills is a number of more basic skills. By using them, intellectual skills are built just like climbing a pyramid of intellectual skills. This is called learning hierarchy. As learning tasks are built up, the entry condition is to be capable of one level lower task. If the learners have failed at practice of the target skill, let them return to one level lower to review how to do it and then try again, depending on the type of the mistake. This type of learning achievement is often seen in arithmetic/mathematics, rules in natural sciences, and grammar of language learning.

As intellectual skills have a clear hierarchical structure, the order to teach them can be easily defined according to the hierarchy (from bottom to top). It also means that if lower-level skills have not yet been acquired, it is difficult to learn a higher level skill. Any skill can be certainly acquired by going down the hierarchy to the level one is capable of and start learning from there upward, but this requires much effort. The cumulative nature of intellectual skills causes a challenge that "once it remains not understood, the next one is not understood more than ever" deepens the problem further, as math haters cry.

9-3-2: Learning conditions of verbal information

In contrast, verbal information is the study to memorize data such as names or symbols that are dealt with once before. Whereas new examples are used for learning intellectual skills, everything to be memorized has to be given in advance for learning verbal information. Although the learning task for verbal information is "to memorize," it does not mean to memorize everything at random without understanding its meaning. It would be better to locate things in the brain in an organized way, rather than to etch them in the memory unorganized.

As the external condition to support learning verbal information, it is considered effective to prepare for building new information into learned knowledge. It is a strategy aiming for the effect that the new information is added in the form of having meanings into the information network that the learner has acquired through past study. This proposal is based on the

research result (i.e., Ausubel's advanced organizer) that if Americans who learn Buddhism are prompted to recall Christianity, which is more familiar to them, it does not become rote memorization because they learn the correspondence relationship between the two that makes learning more organized. In Gagné's words, to recall Christianity, which is already known, corresponds to the entry condition in Event 3, and to introduce Buddhism as a comparison corresponds to providing learning guidance in Event 5.

In learning verbal information, different from the case of learning intellectual skills, the order of learning is not always clear. For example, in learning geography, there is no problem in starting to learn with any countries. In learning English words, the word learned first would make little difference. Therefore, even if the learner leaves a weak part, there is less possibility that it will have a direct adverse effect on the next learning. However, at the same time, it indicates that there is also a possibility that verbal information could be learned discretely, ignoring mutual relationships. In learning geography, reinforcing the information network in the brain is advised, which is achieved by highlighting similarities and differences, maybe learner's own country as a comparison. Utilizing creativity, such as emphasizing similarities and differences by creating a comparison chart would be needed to establish "framework to organize characteristics of the countries."

9-3-3: Learning condition of cognitive strategy (learning skill)

Cognitive strategy, which is considered the third learning outcome in the cognitive domain, is to acquire strategy to increase the effectiveness of one's learning. It is said that to design an effective instruction, the most certain method is building it based on one's own effective learning experience. This is why the harder experiences a teacher has had as a learner, the better lesson she can design for her students. Reverse can be true that the more a child experience effective lessons, the better he acquire indirectly cognitive strategies to learn an effective way.

For instance, as described Event 9 in Section 2, there is a strategy that review is more effective when one starts suddenly with solving tasks in the manner of a "surprise test." Through experiencing a number of surprise tests, if children feel that being given tests increased their ability, they may prepare tests by themselves and try them when they think that they might forget them. On the contrary, if they feel that surprise tests are given by mean teachers who want to make a difference in their scores, they will grow up to be adults who have not had opportunities to acquire an effective use of review in their learning. To experience a variety of instructional strategy that teachers employ in the class is a condition to learn cognitive strategy. Explaining them how they can apply it as an effective learning strategy by themselves (learning how to learn = meta-learning) is one of the keys to foster acquisition of cognitive strategy within the learners.

Leaning condition of cognitive strategy is considered to partially overlap that of intellectual skills. Thus, once they have learned a few tricks that help them learn, first by being taught by somebody and then repeatedly applying it in new learning situations by their own decisions, they gradually become able to utilize the cognitive strategy when it is applicable. It is also vital to increase the attitude to exercise creativity in learning by letting them look back at their way of learning to identify what is effective and what is not effective: this process is called reflection. Although there are still unclear points in the conditions for promoting learning cognitive strategy, its significance is surely growing today amid increasing requirements to raise self-learning ability.

9-3-4: Learning condition of attitudes

Learning an attitude, which Gagné addresses in the affective domain, is a learning outcome with a wide range that includes the overall mind-sets that support human action to "choose." It is considered that choosing an action to pick up a waste can (or not to through one from a running car's window) is exhibiting a positive attitude to environment beautification. Likewise, choosing an action to do homework is exhibiting a positive attitude to learning when a person is pressed to choose to do the homework or play a computer game.

What Gagné takes notice of is the mechanism of vicarious experience (i.e., Bandura's vicarious reinforcement) by observation learning as well as the direct experience of children themselves. It is what is known to be that "by others' faults, wise men correct their own." Television is considered an effective medium to promote learning attitudes, because it has a function of illustrating actual human beings (a hero to make it better) and their choice behavior and to allow the viewers to have vicarious experience of the consequences.

Supporting learning attitudes often requires various other cognitive learning related to expressing intention of attitude as it is manifested in one's choice behavior. For example, to increase the attitude to protect the global environment, knowledge and skills that lead to action must be taught, such as why it is important now and what should be done (= verbal information), or how to act for it (e.g. procedure to collect milk cartons = intellectual skills). Directly pressing them to have a certain attitude could result in forcing them without a success. Approaching through surrounding information and skills is thus required so that the attitude and related actions can be chosen based on individual decision.

On the other hand, there is an indispensable fact, which is, by having classes every day from childhood, negative attitudes towards learning (learning is arid), subject (I hate science), or learning method (video lecture is boring) might have been cultivated, regardless of intentions and consciousness. There is a concept that, when setting learning achievement in the cognitive domain as the objective of the class, learning condition should always be prepared to let the learners have positive attitudes toward the target learning outcomes (this is referred to as "twin objectives," in Briggs & Wager, 1981). It would be better to be conscious of learning attitudes when supporting learning in the cognitive domain (Chapter 10 fore more details).

9-3-5: Learning condition of motor skills

Motor skills are learning outcome not only in gymnastics, technology, domestic science, and the arts, but also cursive handwriting in English or abacus fingering. In motor skill learning, in addition to just becoming capable of doing something using your muscular, speed, punctuality, accuracy, and/or smoothness are required in most cases.

As the condition to support acquiring a motor skill, first of all, there is repeating practices using the body. For complicated movement, a method to separate it into its constituent steps, let the learners completely acquire each step, and then connect them as a whole is considered effective. Recently, in order to realize smooth motion, attention becomes drawn to the effectiveness of training to rehearse the motion in the brain to imagine the successful motion (this is called visualization/image training).

Note: This section is reprint of "Premier to instructional design using Educational Broadcasts, Katsuaki Suzuki (1995), "Chapter 3 Framework to categorize the objective of the class", partially modified.

Section 4 Learning support design based on behaviorism: designing mechanism of drill-and-practice e-Learning

In the 1960s and 1970s, in the era when behaviorist psychology was the mainstream, drill-and-practice type CAI was heavily investigated as a material that makes the most of the advantages of interactivity of computers. This is the research from the viewpoint that it is effective that learners repeat practices at their own pace until they achieve what they have not achieved, receiving feedback corresponding to each of their misunderstandings, in order to support learning. Although the basic design guidance of drill-and-practice type material was established mainly in the U.S. (e.g., summarized in Alessi & Trollip, 1985 ; Salisbury, 1987), the momentum of behaviorist psychology had slowed and the interest of researchers in drill-and-practice material had waned.

The author, whose character is a little perverse, has continued research to widely promote application of control mechanism of drill-and-practice material (or educational campaign), which seems to had been forgotten from everyone (Suzuki, 1989*, 1998*; Suzuki, Iwamoto, & Nagata, 1990*; Suzuki, Iwamoto, & Yashiro, 1989*; Suzuki, Saeki, Futo, & Iwamoto, 1994*). A number of students have been involved in it (for example, Akashi, Suzuki, & Iwamoto, 1994*; Ichinohe, 2002*; Kobayashi, 2003*; Sano, 2003*; Takahashi, 1995*; Moriyama, 2000*). Still now, the activity is continuing. One of the currently progressing projects is a graduation thesis that visualizes the control mechanism of drill and enables self-created drills in a local environment (Sato, Ichikawa, Fujiwara, & Suzuki, 2003*), expanding the project of creating a portal site by collecting existing drill shells (Koseki, 2002*).

Significance of drill-and-practice learning environment is expected to continue increasing. This should not because of the increase in drills that learners are “forced to do” just for memorizing by rote, but as drills “to do voluntarily” that are prepared in an e-Learning environment and effectively support to memorize what the learner intends to memorize, whenever they want. A service to provide drills regularly has appeared in a mobile environment, but there are also a number of places to exercise creativity to the control mechanism, utilizing the results of past research (e.g., Ichinohe & Suzuki, 2002).

In addition, being aware of under what conditions one’s speed of memorization increases by oneself is useful for an active learner who tries to learn a load of things within a limited time. Skills to adjust the drill’s control mechanism (acquiring learning skills, or cognitive strategy in Gagné’s terminology) can be also expected to be learned by using drills. An overview of the mechanism of drill-and-practice as learning support design based on behaviorism, which might be said to be an anachronism, is shown below based on Suzuki (1989), wishing it to serve to convey the idea that drill is not only for “repeating something in order to etch it in the memory.“

9-4-1: Framework of drill-and-practice material

Drill-and-practice material consists of three parts: (1) introduction, (2) practice cycle, and (3) termination. The following functions are required for each part (Suzuki, 1989).

(1) Introduction:

Present introductory information on the drill. Provide summary information of the drill,

including how to proceed, how to stop, and other options available to the learner. In addition, concretely indicate the learning objective of the drill (Event 2 of Gagné's nine events of instruction), clarify the entry condition required for the user of the drill (in the case of intellectual skills), the overall information included in the drill (in the case of verbal information), or the relationship among other related drills, so that the learner can learn the purpose of the drill.

(2) Practice cycle:

As a major part of the drill, repeat a cycle consisting of selection of items, display, receiving reaction, judge, and displaying feedback (Events 6 and 7 of Gagné's nine events of instruction). The learners exit the loop when they break from the practice, when they accomplish the passing criterion, or when they move to the drill for low-level objective in order to recover from a stumble (in the case of intellectual skills). The mechanism that enables learners to practice more effectively depends on the nature of the learning outcome. It also depends on the roles that the drill plays in the overall structure of instructional sequences. Details of instructional strategy used in the practice cycle are discussed in the next section (9-4-2).

(3) Termination:

After the drill is terminated, information on practice status is reported. There could be provided evaluation to the practice result (Event 8 of Gagné's nine events of instruction), indication of the next activity, or making relations between the result of the practice and advanced objective.

9-4-2: Basic design of practice cycles

In order to construct practice cycles that constitute the main part of drill-and-practice type CAI, various aspects of instructional strategies should be considered to provide effective practice conditions. Especially, full consideration is required for (1) Selection of items to be included in the drill, (2) passing criterion for measuring achievement of learning objective, (3) mechanism to select and remove items, (4) form of practices and types of responses, and (5) method to provide feedback.

(1) Selection of items to be included in the drill

One significant principle is that items included in one drill should correspond to one learning objective. Therefore, the difficulty levels of items within the drill should be either constant or gradually become more difficult toward the objective. When the items in the drill are arranged to gradually increase in difficulty level, random presentation, which is an advantage of computers, cannot be utilized; therefore it is regarded good practice to include items with similar difficulty levels in one group of items while separating items with different difficult levels into different groups (or to include in other drills) and randomize within each group. In dealing with intellectual skills, create item groups by collecting various sorts of items from the area covered by the skill as much as possible, so as not to use the same item twice. In dealing with verbal information, collect related information that is mutually confusing, create groups including as many items as one can learn at one time (the amount of information that human being can deal with is regarded 7 ± 2; thus considering some of them have been

already learned, approximately from 10 to 20), and use the same ones repeatedly until each item has been acquired. In terms the length of practice time, the time required for the practice differs depending on the learners; there is an opinion that the length of one drill should be around 15 minutes to prevent the learners from feeling bored or tired (Alessi & Trollip, 1985).

(2) Passing criterion for measuring achievement of learning objective

When correct responses are observed several times in the drill, a judgment is required to exit the practice cycle when the learning objective is consider to have been accomplished. It should be definitely avoided to set the exit criterion to the number of times each item has been shown (regardless of whether or not the response is right), or the number of tasks that are practiced, because the drill is then become a tool to fill up the time.

In dealing with intellectual skills, the leaning objective is regarded as accomplished not by the number of right answers to each item, but by the number of times that the leaner was able to apply the target skill to various sorts of items (e.g., 5 consecutive times) or by the ratio of the right answers to the number of problems (e.g., 8 of 10 questions).

On the other hand, in dealing with verbal information, whether or not the learning objective has been achieved is judged by the number of right answers to each item in the drill. For descriptive questions, two consecutive right answers might suffice; for multiple-choice question three consecutive right answers might suffice, considering that the right answer may have been selected accidentally. Of course, this does not mean actually presenting the same item consecutively; pose the question after the learner has practiced other items or when the learner may have forgotten it, then make a judgment by number of consecutive times that the learner can choose the right answer continuously.

Then remove the item from the drill in order to concentrate on items that have not been learned (refer to 3). When all of the items are removed, exit the practice cycle; the learning objective is considered to have been achieved by the learner acquiring all of the verbal information in the drill. When the evaluation criterion is considered smoothness of immediate reproduction, it could be judged by the speed of response (e.g. give a right answer within 3 minutes).

(3) Mechanism to select and remove items

If items are to be proposed in a predetermined order and the practice is to be continued regardless of the achievement level in the practice, flash cards will do the job, and there is no need to use computers. In a practice in which the order to propose items is fixed, there is a risk of “ordering effects,” in which the learner memorizes the right answer from the link with the item that the learner saw in the past (Salisbury, 1987). Therefore, the advantage of a computer, random extraction, should be utilized here. In addition, a mechanism to support achieving objectives as efficiently as possible should be provided in the drill by sorting out items according to the practice status of each of the learners. The following control mechanisms to select and remove items have been proposed in the past (Alessi & Trollip, 1985; Salisbury, 1987).

(a) Variable Item Interval Drill:

In a Variable Item Interval Drill, the order to present items is defined by mixing the items randomly for the first time. When the right answer is not given, it is not placed at the end of the queue, but posed again several items later (e.g. three times as the second, fifth, and ninth questions). This is a method to give the opportunity for immediate practice for the item answered incorrectly. For an item correctly answered, it will be presented again after all other items are finished, to have a longer interval. This is one of the proposed mechanisms for verbal information.

(b) Progressive State Drill:

Progressive State Drill is a method to use one drill, by gradually advancing its state towards greater difficulty, from pretest, rehearsal, drill, and review states. First select items that need to be practiced by removing the items that are already known, in the pretest state. Next, present questions and their correct answers in a rehearsal state to let the learners memorize them. After that, move on to the drill state, then, as a review, practice items were presented once more. Although this drill was developed for verbal information, it is considered applicable to intellectual skills. Figure 9-7 shows the mechanism of Progressive State Drill.

(c) Three-pool Drill:

Three-pool Drill is a method to control items when there are many items to learn, by categorizing them into three pools: (1) unlearned item pool, (2) learning item pool, and (3) learned item pool. For the learning item pool, select around seven items from the unlearned item pool, which is the number that can be memorized at once. Then remove the learned items by moving them sequentially to the learned item pool. When no items remain in the learning item pool, newly select seven items from the unlearned item pool and continue practice. This is a mechanism proposed for verbal information learning.

(d) Sub-drill Grouping:

In the method called Sub-drill Grouping, prepare mutually related intellectual skills as multiple item groups within the drill. When the learners failed in a group, automatically move on to the item group for the lower-level entry skill that caused the failure in the last group. Once the sub-skill is mastered, move up to re-try the original group, unless there is another lower-level entry skill needed to work on. It can also be applied when it needs to move on gradually toward more difficult task groups depending on achievement level of practices aiming at achieving a certain learning objective. A mechanism proposed for learning a series of intellectual skills.

(e) Adaptive Concept Learning Drill:

Adaptive Concept Learning Drill is a mechanism proposed for practicing multiple coordinate concepts (the objective is to identify the examples of a concept, which are non-examples of other coordinate concepts; e.g., categorization according to word class, such as noun, verb, etc.). It is proposed to control practices focusing on confusing concepts based on mistakes made by learners. When the learner gives the

correct answer to what concept an item belongs to (e.g., the answer for “Japan” is noun), the next item is selected randomly from examples belonging to other coordinate concepts (e.g., what is the word class of the word “warm”?). When the learner gives a wrong answer (e.g., if the answer given for “Japan” is pronoun), the next item is selected from the items belonging to the concept of the item for which the learner gave the wrong answer (selecting one from the task group of pronoun; what is the word class of the word “that”?). In this way, drill controlled for confusion that each individual learner is having a problem with.

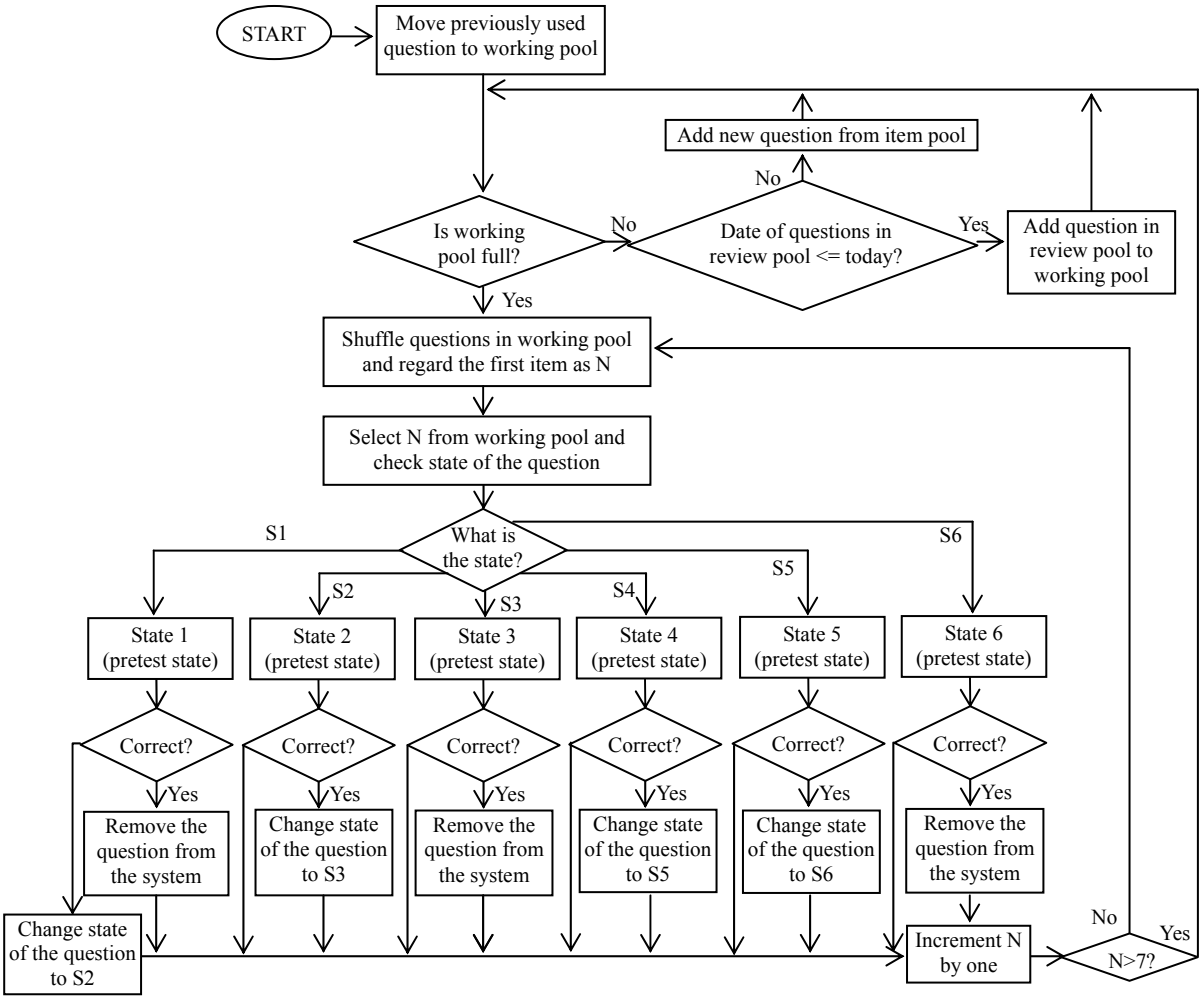

Figure 9-7: Control flow of the Progressive State Drill

(4) Form of practice and type of response

The purpose of practice is to search information or skills that the learners have once acquired (stored in long-term memory) and give an opportunity to try using it (Events 6 and 7 in Gagné's nine events of instruction). Therefore, the main form of the practice is exerting the achievement that the learner has acquired (description for verbal information, application for intellectual skills) to the task proposed by the computer, judging achievement level based on the status of exerting, and giving feedback. The reason to record learning history is, in this regard, not to score the learners, but to determine what feedback to give and what is the most appropriate question to give as the next question according to the status of exertion.

The various types of mechanism of selection and removal of items described above in (3) are developed to maximize the effectiveness of the drill when a wrong answer is given to the drill. Failing to fully utilize the advantage of the drill due to learners always feeling "evaluated" is to be avoided. In this regard, especially at the beginning of the practice, like the "rehearsal state" used in Progressive State Drill, the form which gives correct answers or hints at the learners' request can also be used. It would be better to create a form of practice that enables the learners to practice without any worries and to realize increases of their own ability.

As for types of responses, we can divide them into two types: (1) reproduction type (free description, blank-filling and filling uncompleted part) and (2) recognition type (yes-no type, multiple-choice, sorting). In the CAI using currently available commercial authoring system, it may be difficult to create recognition-type tasks with flexible response judgment. However, a system is considered to be too primitive (Wager & Wager, 1985) if it judges answers to be wrong for mistakes of uppercase and lowercase, punctuation, answers with double-space, without a mechanism to check and indicate those mistakes. In dealing with verbal information, the system should at least be capable of judging whether the answer has a mistake in spelling or whether other wrong information is written as the answer. In dealing with intellectual skills, it should be capable of identifying what sub-skill is missed in provided wrong answers, and they should be capable of processing them accordingly; otherwise, reproduction-type should be avoided.

In recognition type problems, effectiveness of the drill depends on the quality of choices; therefore its mechanism needs to be carefully considered. In dealing with verbal information, other items included in the same drill group should serve for wrong answer choices. As the item in question is confusing enough with other items in the same drill, choices can be created by mixing the right answers for other items and for the item in question. It should also be equipped with a randomization mechanism to determine the order to display the right answer and wrong choices.

In a drill dealing with intellectual skills, it requires creativity for creating choices so that feedback can be given to explain the cause of mistake depending on the nature of the mistake. It is expected that the choices have been selected in such a way that when one of the sub-skills is missed, one of the wrong choices would be selected as "correct," based on the certain kind of misunderstanding. It would be good to consider giving a choice that can check overgeneralization of the target concept.

If using normal multiple-choice type results in giving too many hints, a method of providing more candidate choices than the number of items in a fill-in-blank question can be adopted. In any cases, recognition-type questions will give away the correct answers that the learners are supposed to pull out from their mind, the passing criterion must be made slightly more difficult than that of reproduction-type problems. The number of choices is one of the major factors to determine the difficulty of the drill; therefore, the most effective number should be determined based on the status of the practice.

(5) How to provide feedback

Feedback is given immediately, corresponding to each of the responses of the learner and in a form corresponding to the response. The basic principle is that, if the answer is right, give motivational feedback; if the answer is wrong, give informative feedback (Alessi & Trollip, 1985; Keller & Suzuki, 1987).

As for feedback to the right answer, there is an opinion that it is enough to just inform the learner that the answer is right, since the fact that the answer is right itself has an effect of increasing motivation (for instance, Wager & Wager, 1985). However, it may be effective for some learners to give additional points or to show a car moving from the start toward the goal little by little with every right answer the learner provides, in order to show the rate of contribution of the right answer that the learner currently gives, on the way toward achieving the objective of the drill. In order to try to maintain the interest of the learner, some drills give extrinsic rewards that have no relation with learning objects, such as drills built into an environment of a shooting game, in which learners can shoot one bullet after every right answer they give. Careful consideration must be taken not to make the achievement of the objective less meaningful. As for game-like rewards, if any, it would be reasonable to give them when the learners achieved a certain level of learning objective as one of the options, rather than after every single right answer.

Feedback to a wrong answer needs to be informative. The learner's misunderstanding that resulted in the wrong answer needs to be clarified. Informative feedback must be given, rather than giving feedback such as "It is wrong. Try again," regardless of the cause of the wrong answer. With such feedback as "It is not correct. This is the answer for xxxx," or "Spelling is not correct. Try again," the learner will be informed of what was wrong that was judged as the mistake. In dealing with intellectual skills, provide feedback explaining where the mistake occurred and the reason why, or even, you may include a review of sub-skill at one level lower as a part of the feedback.

Section 5 Learning support design based on constructivism

Criticism that ID has become outdated is mainly triggered by the trend of constructivism. The base of ID was established in the era of behaviorist psychology, and it has been proposing "how can we teach effectively," by adopting research results of cognitive psychology. Following this trend of adopting research results, it is time to seek the way to utilize research results of constructivism in ID. Thus, learning support design based on constructivism will be introduced in this section.

Constructivism falls under epistemology; its standpoint is "to know is to construct its meaning inside oneself" (Miller & Miller, 2000). The theory of Piaget, a psychologist, is revisited, and learning is considered the process of human knowledge being taken into a cluster, called "schema," or forming a cluster. Another standpoint is Vygotsky's zone of proximal development (ZPD) that knowledge is formed socially through interaction with others (social constructivism). In behaviorism and cognitivism, learning is regarded as the process to acquire knowledge that can be perceived objectively (the same for everyone: objectivism); however, constructivism regards learning as the process by which every learner forms the meaning (different for each learner).

Even if we take the standpoint that knowledge is formed in the brain of every learner, this does not mean to deny instruction. The Committee on Developments in Science of Learning (2002) points out in their book "How people learn: Brain, mind, experience, and school" that people who espouse constructivism misunderstand this point and this sometimes results in them having a misconception that, "the teacher should never tell students anything directly, but , instead should always allow them to construct knowledge by themselves" (p.11). Constructivist's opinion of this sort is confusion of "a theory of pedagogy (teaching) with a theory of knowing" (p.11) and it causes limitation in their instructional activities, by pursuing formation of knowledge by students themselves without considering matters of instruction of "how to teach." It is also indicated that "teachers still need to pay attention to students' interpretations and provide guidance when necessary" (p.11). Regardless of epistemological camps, one should be aware that "learning support design" is providing an external support to facilitate the process of learning.

As ID models based on constructivism, some models have been presented in the past, such as "anchored instruction" (Suzuki, 1995) that supported the Jasper project, which teaches mathematics through a video story in real-world contexts (introduced in Chapter 8) and Flexibly Adaptive ID Theory (Schwarts, et. al., 1999), proposed as an advanced form of anchored instruction. While there is an opinion insisting that "there is no established ID theory based on constructivism as epistemology" (Miller & Miller, 2000, p. 162), there is also a positive view that "the major trend of instructional theory as ID guideline for the present technology-based instructional material is mainly based on the principle of constructivism that considers the roles of active learners important, who try to recognize meaning from information and understand it" (Oliver & Harrington, 2000, p.179). As principles of learning support design based on constructivism, three items are often indicated: (1) collaborative work, (2) multiple-viewpoint approach, and (3) authentic context.

Figure 9-8 shows the elements of learning support as organized by Oliver and Harrington (2000), who takes a position that "the major trend of instructional theory as ID guideline is based on the principle of constructivism." They can be utilized when possible, but you don't have to think that they have to be utilized in all cases (whenever, to whom, what to teach).

Figure 9-8: Elements of online learning support based on constructivism

Element of learning support	Summary
Authentic context	Teach in an actual context where the knowledge or learning outcome would be used. By proposing context with reality as it is, ensure "rich contextual affordances."
Authentic activities	The learning activity itself should be real. Let learners work on one complicated, time-consuming task, rather than on a number of piecemeal tasks.
Modeling of experts' work	Give an opportunity to learn what experts have thought and done. Let learners observe episodes that seem like actual situations and join.
Multiple roles and perspectives	Provide information from multiple perspectives to add complexity. Provide information looked at from various perspectives or give an opportunity to see different perspectives from learners themselves through collaborative work.
Collaborative construction of knowledge	In the real world, things are learned more through group activities than through individual activities. Let learners create pairs or small groups to learn and construct a mechanism to reward achievement by the whole group.
Reflection	Give an opportunity to reflect on learning achievement and process. A mechanism that enable learners to go back to any stage to review their record or to compare their way of doing with that of an expert or those of other groups.
Making explicit tacit knowing, Articulation	Enable learners to confirm the knowledge they have learned. By giving a task as complicated as they can articulate, first as a group, then as an individual learners, enable them to recognize the learning achievement.
Coaching and scaffolding by teachers at a significant point	Teachers should play the role of coach or facilitator. Adopt coaching by fellows who are in an advanced stage in learning.
Authentic assessment of learning achievement	Assess whether or not learners can solve tasks when they are in a context with reality. In the process of performing authentic activities in an authentic context, integrate assessment activity as indivisible parts.

Note: the body text by Oliver & Harrington, 2000 (pp. 180-182), summarized by Suzuki.

Lebow (1995) organized five principles of ISD based on constructivism in the textbook "Instructional design fundamentals: A reconsideration," which seeks how to respond to criticism to ID. The points to keep in mind when exerting ISD based on constructivism are shown below. In other words, it is the answer to a question "to what problem can constructivism serve as the method of solution." Figure 9-9 shows the essential points of it. They should be fully utilized in preparing a learning support environment if they serve as some help.

Figure 9-9: Five principles of ISD based on constructivism (Lebow, 1995)

Principle of ISD	Summary
(1) build a buffer to protect learners from "what have potential adverse effect on learners" in instruction	Focusing on cognitive domain, disregarding affective domain accompanying learning (ARCS is exceptional). Proposing objectives along with performance tests based on criteria, and task analysis. Providing the order to learn or the environment prescriptively. Believing the possibility of a danger to take a wrong direction of efforts unless an objective is set first. Those fundamental premises of ISD are accused of being irreconcilable with the concept of constructivism. Do not abandon setting objectives or using other ISD techniques, and put "avoiding damaging learners" first. Pay serious attention to learners' mentalities and avoid forcing them to reach the cognitive objective at any cost. Ultimately, remember the phrase "to teach is to leave the control to the learners."
(2) Provide a "context" that supports connection between autonomy of learners and relatedness of learning achievement	It is more effective to learn autonomously through activities with a sense of purpose rather than learning as directed by other persons. This has been explained through ISD research and is supported also in constructivism. Give a "scaffold" through activities to tackle "authentic" tasks to increase potential in "zone of proximity." It does not insist leaving them; it is based on a certain level of activities of support. Attaching significance on collaboration in groups and aiming for increasing metacognitive skills, advanced reasoning skills, and interpersonal communication skills through the sharing of responsibility and mutual interdependence. Focus on designing of contexts (cf. Chapter 14).
(3) Embed the reasons for learning into the learning activity itself.	To the tasks to develop applied skills that have been traditionally regarded as "transfer" or "inert," continuous and embedded learning at application is considered significant in constructivism. In order to foster acquisition through experiences, it focuses on learning through solving problems with reality and satisfaction of accomplishment, rather than telling why it is important. On the other hand, it seems that less significance is attached to obtain proof of getting to the predetermined goal. Unite objects and methods into the whole learning activity to integrate learning activity and achieving objectives.
(4) Promote utilization of the skills/ attitudes to support self-regulated learning so learners can assume respon-sibility required through the process of restructuring knowledge.	Whereas ISD places significance on promoting learning by continuous application of prepared stimulus, constructivism is a process that learners change themselves through their emotions, intuition, attitudes, values, interest, relationship with others, and commitment. It uses a technique in which learners are given a challenging task that triggers learners to restructure their knowledge by themselves. Consider preparing tools or resources for learning that enable learners to solve a task in a complicated context, rather than supporting them in a condition easy to understand by organizing prerequisite knowledge and skills.
(5) Strengthen the learners' tendency to engage in intentional learning process. Especially, form a habit to explore errors strategically.	In order to strengthen the tendency to learn intentionally, take into consideration the way of learners' thinking about knowledge and learning process, self-evaluation on their ability and efforts, and influences from learning environment. Due to adverse effects from existing schools, they cannot acquire the skill to control their learning, and fail to evaluate themselves correctly. In ISD, "error" is regarded significant, as a sign that indicates the necessity of therapeutic feedback, as information to improve materials in formative evaluation process, or as an indicator of achievement level. On the other hand, constructivism concerns adverse effects from environment, focusing on subjective effects of self-efficacy of "error." It attaches significance on being capable of utilizing their knowledge in contexts, rather than getting the right answer. Here, do not abandon the evaluation itself; let learners utilize the evaluation as a reference for promoting activities of setting objectives or self evaluation, and adopt creative means to let learners to have a conviction that "it is possible to achieve a meaningful result if I continue strategic efforts intentionally toward the objective."

Note: From the body texts from Lebow (1995), pp. 175-187, briefed by Suzuki.

The author advocates eclecticism in Gagné's wake (he is my mentor). Eclecticism refers to a standpoint that adopts everything if it is an effective means to solve problems regardless of its theoretical standpoints. In my opinion, this is the most fundamental concept of ID (or educational technology in general), because we are to serve for learners who are having difficulties in their learning. As for the ideas to support learning based on constructivism, many ID researchers advocate eclecticism, considering that what can be used should be used and "placing priority to solve a problem" without sticking with a certain theoretical canps (Wilson, 1999; Jonassen, 1999; Smith-Gratto, 2000).

Smith-Gratto (2000) considered a scenario to combine behavioral ID and constructive ID, which were "regarded illogical by the majority (especially difficult to accept by constructivists) (p. 233)." Based on Jonassen's (1990) standpoint that constructivism is effectively applied to more advanced learning tasks and basic skills can be acquired with methods other than constructivism, he indicates two scenarios as shown in Figure 9-10.

Figure 9-10: Scenario to integrate behaviorism and constructivism (Smith-Gratto, 2000)

Scene	Scenario
Word drill	Adopt a drill based on behaviorism for learning words. In the drill, constructive means can be used, such as activating existing knowledge to connect them with new words.
Simulation	Simulation based on constructivism requires significant efforts by learners. Therefore, prepare short programs to learn necessary skills to perform the simulation from the menu. By enabling learners to select them according to necessity, the load can be reduced.

Note: From the body text from Smith-Gratto (2000) (p. 234), briefed into a table by Suzuki. "Activating exiting knowledge" corresponds to Gagné's third event of instruction.

The contents in the ID model tool box are becoming more complicated than ever, such as drills based on behaviorism, framework to support learning process based on cognitivism, or construction of learning environment based on constructivism. Espousing a specific concept or principle and decide that "I will use this method only" makes one feel easy. On the other hand, seeking the optimum combination of tools and their usage to create better things on the whole requires significant cognitive efforts by instructional designers, but it should increase the possibility of creating good things. In closing this Chapter, the author's proposal is shown below to organize the area to be covered by each theoretical standpoint, which has been introduced, along with two axes: complexity of learning task and proficiency of learners. (Figure 9-11).

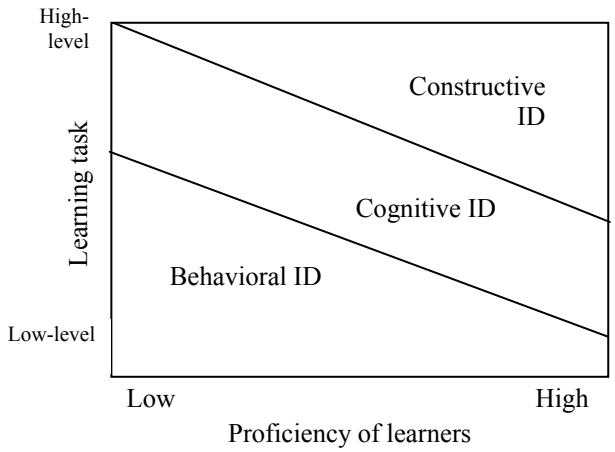

Figure 9-11: "Area to be covered" by behaviorism, cognitivism, and constructivism (draft)

Column: Support learning with printed materials

This is the era of multimedia. It has long since been said that we are heading toward a paperless society. However, it is difficult to imagine a class without any paper. Printed materials are the handiest, ordinary, and frequently used self-created instructional materials. There is no special know-how for printed materials, which anyone can create. However, since anyone can create them anytime and since its technical requirements are low, there is demand for basic universal know-how (Suzuki, 1994).

Ten years ago, the author, who was perverse, wrote an article about creating printed instructional materials, in a computer magazine featuring "increase motivation." That article started with the sentences written above. Extracting what is related to Gagné's nine events of instruction discussed in this Chapter, I place it as a column here. I think that skillful use of printed instructional material is also necessary in e-Learning. I wish you learn how Gagné's nine events of instruction can be applied in handy printed instructional materials (Note : Due to the nature of the magazine, it was written as learners = children. Please pay careful attention to what degree what is written here can be applied to adult learners).

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To learn something means to achieve three conditions: putting into the brain (memorize), storing in the brain (store), and taking out from the brain (retrieve). You may feel you have understood it while you are listening to the teacher's explanation, however, if you cannot answer when the teacher asks you a question, if you have forgotten it the next day, or if you cannot recall what your are supposed be know, you cannot say that you have learned it. Therefore, it is not enough just to create a material that is easy to understand, if you intend to create a material that helps learning. You need to create a material that is easy to learn: easy to memorize, easy to store, and easy to retrieve.

Research results on the process of human learning provide a number of hints. Among then, Gagné's nine events of instruction (Suzuki, 1993), which organizes an external attempt to support learning process in terms of designing classes/materials, is a good reference. The hints and their explanations are shown below:

Hint #1:
Include clear directions for learning activities in a material, even if it intends to provide information, so that children take an active interest in the material.

Explanation:
Materials that intend to provide information can be materials that provide summary of the contents to learn or additional information that complements textbooks. It is an attempt that corresponds to Gagné's fourth and fifth events of instruction.

Learning with printed materials is not only a process to read and memorize the given information. It also involves such process that (1) children explain the contents of the material by themselves, (2) interpret them by themselves, and (3) restructure information by combining with their existing knowledge in their brain. From this viewpoint, it is important to use creative means that enable children to take an active interest in the printed material.

Let's make materials easy to learn by requiring the children to perform the following activities, as well as using creative means to construct materials easy to understand.

- Propose a learning objective and let children aim at it (Event 2).
- Provide a framework for information and let children think about whether or not the information is applicable to the framework (Event 3).
- Embed questions and proceed with a class by letting children answer them.
- Let children draw lines (in colors) where they think it is important.
- Let children outline information on the printed materials on their notebooks from their own points of view.
- Let children gather information related with the printed material or let children create the next material.

It is important to make the print materials easy to understand by presenting information in a structural way. On the other hand, continuing providing printed materials that are easy to understand may generate an attitude in children that passively accepts pre-organized easy information.

The ultimate objective is to raise children who can exert creative means to make an ordinary textbook easy to learn (thus, acquisition of learning skills). Every child has built different experiences in their learning or living. It would be better to cultivate skills to exert creative means to build new information into their brains with those different experiences so that they can build their own understandings.

Hint #2:
Printed materials for practice can play five roles, according to the timing to use and methods, which are providing information, practice, test, review, and confirmation of entry conditions.

Explanation:
For example, a teacher created a printed material that requires children to fill in, such as filling blanks or calculation. Of course, no answer is attached to it. The material can be utilized in the class in five ways as shown below.

(1) Providing information (Events 4, 5)

It is natural for teachers to explain new things to learn and to use printed materials for practice to check whether or not children understand them. However, instead, just distribute the materials for practice and let children fill in the blanks by extracting necessary information from the textbook by themselves.

(2) Practice (Events 6, 7)

Learning new things is not completed only by reading textbooks, or listening to teachers' explanation to think "I get it." Practice is essential, in which children check whether they can do it by themselves without references. We never know whether or not children can extract what they put in their brain only by making notes of what is written on blackboards, solving tasks while looking at textbooks, or going over example

answers.

First, use the printed material for practice to try and check what they can do without references. For a point they are unable to answer, it is effective to let them confirm the right answer (not let them copy the answer), then let them answer it again without references, using another blank sheet of paper.

(3) Test (Event 8)

The printed material for practice can be used for the assessment of their ability. Give them a test after providing enough time to practice in order to confirm whether they achieved it or not. The test can be given in the same way as in practice; however, it is the actual test, so score it. (Needless to say, it would be better to avoid recording the scores of practices as grades at ordinary times. Practice is the opportunity to learn from making mistakes.)

(4) Review (Event 9)

Review comes when the learners lose their memory. Review, which is given when the class has new contents and children may have forgotten it, should start with tackling tasks with no references, not with reviewing textbooks (because it does not help to confirm whether or not they are still capable). The materials for practice can be used here also. Let them try the materials for practice without any preparation. It serves as a good review.

(5) Confirming entry conditions (Event 3)

A review that is conducted at the point of studying related more advanced contents is called confirming entry conditions. A review of the previous class as introduction of classes is to awaken items that are required as premises in the current class, which may have stored deeply in the brain, and to let them prepare for new items, creating relationships with them. Then, the printed material for practice can also be used here. Children have learned them before (or are supposed to have been), in the same way as in practice, it is better to start with solving tasks.

It may not possible to use the same printed material for those five occasions continuously. Especially in the field of learning applied skills such as calculation or grammar, similar tasks (new examples) need to be prepared in order to prevent obtaining the right answer by memorizing the answer itself. There is no need to use printed materials in all of the five occasions while learning the same contents. However, it would not be bad to seek to create a printed material that can be used several times, while foreseeing those five occasions.

It would be a good idea to do something new with printed materials for practice, not only just using them for practices. If you think children can understand, you can teach that the printed material for practice can be used in various ways, as a learning strategy. Then, children, who live in the modern world with advanced copiers, may use the distributed printed material cleverly in their own ways (this is also acquisition of learning skills).

> Creating printed instructional materials that are easy to acquire requires designing what learning activity children will do along with designing the printed material. It is better to consider how to promote learning of children in terms of the context of classes and relationships with learning activities on the whole, rather than just considering creating good printed materials.

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Source: Suzuki, K. (1994). "Printed material to increase motivation (commentary)", 'New Educational Waves', August, 1994, 44-49

 **Column: Five key points for constructing CBT material** 

In 1996, the author published an essay titled "Creating a stack for education for university teachers: Introduction of practical instructional design." I explained my own experience in developing computer-based material for self-learning of German language learning. As this essay is available on the Web, some have made reference to it. Here is a reprint of the list of key points for learning support design. The five points are: (1) Consider the entire structure, (2) Pay attention to user control, (3) Use creative means to give tasks, (4) Use creative means to present information, (5) Consider how to process responses and feedback.

Key Point 1. Consider the entire structure

- The users should know the entire structure of the material
- The users should be able to identify the location where they are now
- The material has a menu structure that enables the users to use the material partially
- Hints to learn which items first are available in the menu
- The material does not include "explanation screens" that require the users to press "Next" continuously

Key Point 2. Pay attention to user control

- The user can go back to the previous screen or the menu screen whenever desired
- The user can break, terminate, and resume from there again whenever desired
- Hints or options are provided to show supplementary information
- The users can select examples according to their interests or change parameters
- The users can set the number of practice items or the length of practice time by themselves
- How much options the users are given about the way they learn

Key Point 3. Use creative means to give tasks

- No identical questions appear in the same order every time
- A sufficient number of questions are prepared
- The users can proceed to the next stage after they completed a lower level questions, if they obtain good result in the practice
- The users can go back to review the material, by existing practice when they are obtaining bad results
- Items that the users completed successfully are marked in the menu

Key Point 4. Use creative means to present information

- Include a small amount of information on one screen. Watching a complicated screen for a long time leads to tired the eyes.
- Display information to be highlighted in different colors, in large letters, in different fonts, with underscores, or with being enclosed by a box. However, too much of such highlighting reduces its effect.
- Provide concrete explanation using illustrations, figures, or pictures imported by imaging scanners.
- Do not display information at once on the whole screen; divide the information into information groups and display them sequentially by pressing a button.
- Combine questions to avoid continuous one-way provision of information.

Key Point 5. Consider how to process responses and feed back

- For users who are not accustomed to using the keyboard, allow them to enter answers simply by using the mouse only, numeric keypad only, or software keyboard on the screen.
- Pay attention to increase the users' input skills naturally along with using computer-based instructional material.
- Remember that the basic principle of feedback is to "praise" them when their answers are correct, and to "help" them when their answers are not correct.
- A practice with no feedback to incorrect answers is a "test." In practices, allow the users to learn through making mistakes, by measures such as giving hints to a question they failed and letting them answer again.
- For multiple choice questions, expect types of incorrect answers and prepare corresponding "informative feed back (explanation on what is different)" for each of them.
- For descriptive (fill-in-blank) questions, distinguish and anticipate mistakes at entering answers and incorrect answers by misunderstanding, and take measures corresponding to them.

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Source: Suzuki, K., & Saeki, K. (1996). *"U.S.A. Education Ware Best 100"*, Varsity Wave, [Available online] http://www.iwate-pu.ac.jp/home/ksuzuki/resume/books/1996a03.html

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End of chapter report assignment (Chapter 9)

Write a report on one or more of the following three assignments:

1) After reading this chapter (Chapter 9), write a report including questions , comments, opinions, or thoughts you have. If you have had past experience, additional information, or have conducted research (attach the name of the source of information), include them to deepen your understanding.

2) Analyze learning support design of an existing e-Learning instructional material based on Gagné's nine events of instruction. In analyzing, propose an idea for improvement considering that not all of the nine events of instruction are always included in one instructional material and that including all of the nine events of instruction in one instructional material is not necessarily the best way. Without limiting to examples of e-Learning, you can analyze and compare your experiences as a student in school or company, or educational activity you are involved in.

3) Analyze the three theological standpoints introduced in this Chapter, considering the differences among them and giving an existing e-Learning educational material as an example. Without limiting to examples of e-learning, you can analyze and compare your experiences as a student in school or company, or educational activity you are involved in.