

# A Framework and System for Scenario-Based Instructional Design and Implementation

**Kentaro Go**

Center for Integrated  
Information Processing,  
University of Yamanashi  
Kofu 400-8511 Japan  
go@yamanashi.ac.jp

**Takashi Mitsuishi**

Graduate School of Educational  
Informatics  
Tohoku University  
Sendai 980-8576 Japan  
takashi@ei.tohoku.ac.jp

**Yuki Higuchi**

Graduate School of Educational  
Informatics  
Tohoku University  
Sendai 980-8576 Japan  
yukix@ei.tohoku.ac.jp

## ABSTRACT

This paper describes a process model for designing and implementing instruction using various multimedia instructional materials. Our model takes a scenario-based approach as its central concept. It conceptualizes the whole process of evolving multimedia instructional material as a double-loop of activities in which teachers and students work together to enrich it. The external loop comprises planning, implementing, checking and evaluating instruction, whereas the internal loop is made up of its implementation, verification, and modification. We provide a formal definition of the scenario used in the double-loop model and illustrate an example of how scenarios are used in the model. We also explain our instruction system, which facilitates activities in the double-loop model. The evaluation of our instruction system shows that the use of IMPRESSION is acceptable in class room.

## Author Keywords

Formal modeling, instructional design, multimedia instruction, scenario, scenario-based design.

## ACM Classification Keywords

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

## INTRODUCTION

Recent development of information and communication technologies provides opportunities to design and use new forms of education such as e-Learning and distance learning. On the one hand, this form of education affords us the flexibility of time and place; thus, it truly presents the possibility of enhancing the students' educational opportunity and outcomes.

On the other hand, it may increase instructors' workloads. Instructors must learn how to create, edit and present documents with various multimedia tools such as authoring, database and presentation tools. Instructors may be compelled to allocate more time to creating multimedia documentation than just developing conventional ones for class activities. In addition, use of multimedia documents in teaching may restrict the flexibility of instructors' class activities because of technological limitations of current

tools. For example, instructors work on multimedia documents in advance of their classes and follow a sequence of multimedia documents in class; however, it is difficult to update the multimedia documents while teaching. Such a situation is much worse in computer-supported distance learning situations because the technology used in teaching plays a central role.

This paper is intended to propose a process model of evolving multimedia instructional materials. The paper examines the model using an example and illustrates our instruction system, which supports the process model execution. Our motivation on this project is derived from theory and practice in human-computer interaction [3]. To be precise, design of usable and useful interactive systems requires a model, which explains the activities and context of use. Similarly, design of instruction requires a valid model that illustrates activities of students and teachers in class and in the classroom context.

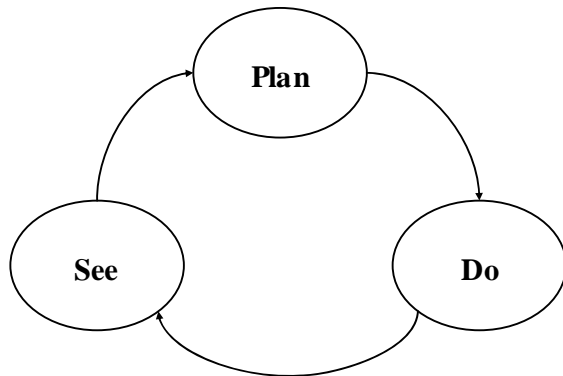
## MODELS FOR INSTRUCTIONAL DESIGN PROCESS

### Traditional Model of Instructional Design Process

Most traditional models of instruction design process have their root in the ADDIE model [5]. This model is intended to clarify instructional activities such as designing instructions and improve students' learning environment. The ADDIE model and its derived models [4, 8, 9] are intended mainly to develop self-learning materials. They are based on a Plan-Do-See cycle on instructional design process as shown in Figure 1. The plan phase analyzes students' properties, design instruction plan, and develop instructional materials. The do phase performs instructional act based on the designed plan with the developed instructional materials. The See phase evaluates the instructional materials and the instructional plan used.

The Plan-Do-See cycle on instructional design process can be applied to face-to-face classes using computer tools and multimedia data. A teacher plans his/her instruction and prepares materials in slide-sheets form using some presentation tools (e.g., MS PowerPoint) before class. During the class, the teacher presents the materials sequentially one by one in a classroom. After the class, the instructor evaluates his/her instruction and materials used in

the class by recalling the students' reactions to the instruction to design or redesign future classes. In other words, the Plan-Do-See cycle is a macro model, which explains teacher's inter-class activities and assumes instructional plan and materials are relatively stable in phases, especially in the do phase.



**Figure 1. Traditional instructional design process model.**

However, even with a carefully thought-out plan, unexpected events occur in classroom. The Plan-Do-See cycle model does not explain what happens in classroom. If we strictly follow the cycle, a teacher reviews and modifies his/her instruction not during the class but after the class. In reality, the teacher deals with unexpected events in class. The teacher could change the course of instruction if students would not understand his/her instruction, and the teacher creates and shows answers if students might ask unexpected questions. In other words, the teacher conducts formative evaluation and modification of the original instruction on demand immediately during the class. To address the issue and incorporate it into process model, we focus on the do phase of the Plan-Do-See cycle model and employ more micro view in the phase. It leads to our double loop model of instructional design process.

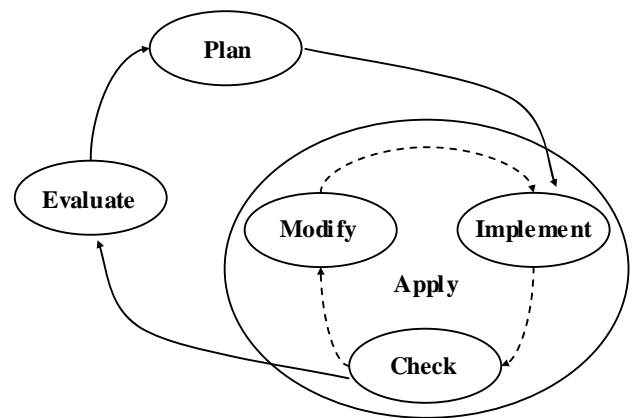
### Double Loop Model

Scenario-based instructional design and implementation forms a double-loop structure. Design and implementation require a whole process of evolving multimedia instructional material as a double-loop of activities in which teachers and students work together to enrich it. Figure 2 depicts an overview of the double loop model. The external loop consists of three phases: planning, applying, and evaluating instruction. The internal loop comprises three phases: implementing, checking and modifying instruction.

The external loop represents the process of teacher's activities for a class. In the Plan phase, a teacher plans instruction of his/her class and prepares materials for it. In the Apply phase, the teacher conducts the class based on the planned instruction, which is the outcome of the Plan phase. The teacher would modify the instruction based on the result of formative evaluation if needed in the internal loop.

In the Evaluate phase, the teacher conducts summative evaluation after the class in order to design or redesign his/her instruction for future classes. This is done by comparing the planned and implemented instruction that is the outcome of the Apply phase. Instructional plan of the class will grow through the iteration of external loop.

The internal loop represents the process of implementation and modification of instructional plan through formative evaluation in class. In the Implement phase, a teacher conducts instruction based on the instructional plan designed in the Plan phase. In the Check phase, the teacher conducts formative evaluation by referring to differences between the expected reactions of students in the plan and the actual reactions against his/her instruction. In the Modify phase, the teacher revises the rest of plan based on the result of the Check phase if needed.



**Figure 2. Double loop model.**

### Formal Definitions

Scenario-based instructional design and implementation is a process model in which instructors define instructional contents by writing instruction scenarios, applying them, evaluating the applied scenarios, and revising the original instruction scenarios. Different communities use different views of scenarios [6]. Therefore, we employ the following definitions relating to scenarios. Note that we leverage the following formal definitions when we design and develop computational support systems.

**Definition 1 (Instructional material):** Instructional materials are multimedia documents used in class to teach. Examples of teaching materials include video clips, pictures, diagrams, and web pages. Instructional material is also called teaching material.

**Definition 2 (Instructional content):** Instructional content  $c$  is defined as a sequence of teaching material  $m$ . Put more formally,  $c = m_1, m_2, \dots, m_n$ . Instructional content is also called instruction. In a class situation with information and communication technologies, instructional content

represents the presentation order of multimedia instructional materials.

**Definition 3 (Instruction scenario):** An instruction scenario is a story that contains instructional contents and various related information. The instruction scenario ( $IS$ ) is defined as a four-tuple  $(A, B, G, e)$  for which  $A$  is a set of actors,  $B$  is a set of background information,  $G$  is a set of goals, and  $e$  is a sequence of actions and events. Elements in  $A$ ,  $B$  and  $G$  have correspondence: actor  $a_1$  has specific background information  $b_1$  and a specific goal  $g_1$ . An instruction scenario is represented as  $(a, b, g, e)$  if each set contains a corresponding element. In a class situation, the actor is usually a student, a teacher, or both.

A sequence of actions and events  $e$  contains the instructional content  $c$ ; that is,  $e$  interleaves the instructional materials of  $c$ .

**Definition 4 (Scenario-based instructional design and implementation):** Scenario-based instructional design and implementation are working processes of creating and examining an instruction scenario or its iteration.

#### Example of Double Loop Model: A Computer Science Class for First-year Students

Assume an instructor has a course of introductory computer science (course number: CS1024) for first-year students in college. In this course, she teaches liberal arts students basic knowledge and skills with regard to computers. The first class of CS1024 (shown as CS1024-1) aims at a brief introduction to the history of computers.

##### Plan phase

She works on and prepares instructional materials of the class summarized in Table 1. She uses a web page of the course website to show the day's agenda. She shows a video clip to briefly explain a history of computers. She presents an MS PowerPoint slide to discuss the relationship between computer hardware and software. She conducts a demonstration of actual software such as MS Word and Excel to show examples of computer applications. She shows a web page of the course website to explain the day's homework.

Her initial lesson plan is to present the prepared instructional materials in the following order of presentation that represents the instruction content of the class. It starts at showing the day's agenda and ends at explaining homework.

**Instructional content:**  $c(\text{CS1024-1}) = m_1, m_2, m_3, m_4, m_5$

The instructional content  $c(\text{CS1024-1})$  can be represented as a graphical representation such as Figure 3.

Material id	Content	Format
$m_1$	Agenda for today's topics	Web page
$m_2$	Brief history of computer	Video clip
$m_3$	Diagram of the relationship between computer hardware and software	MS PowerPoint slide
$m_4$	Example of computer application	Software
$m_5$	List of homework	Web page

Table 1. Instruction materials of CS1024-1

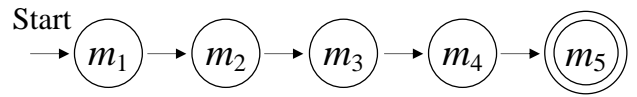


Figure 3. State chart representation of  $c(\text{CS1024-1})$ .

The instructor envisions a class scenario while she is preparing the instructional materials. As specified in Definition 3, the scenario consists of actors, background information, goals, and a sequence of actions and events. The following scenario is in textual narrative form.

**Basic Scenario (Nick experiences the first class of CS1024):** Nick is a first-year student of history department. He takes CS1024, the introductory computer science class at the first semester in college. He will learn computer and information literacy for college students in this class.

CS1024 is held at a computer lab on campus. The computer lab furnishes a desktop PC at the instructor's desk. The PC display image can be presented on the front screen of the computer lab using the ceiling projector. In addition, each student's desk has a desktop PC.

In class, Nick looks at the day's agenda, which is projected on the front screen. As directed by the instructor, he operates the PC and opens a web browser to display the day's agenda page on the screen. The instructor's talk progresses to the history of computers. The instructor shows a video clip for the history of computers on the front screen. The video clip shows basic computer components and how they function together. Nick becomes interested in how a CPU processes data in its main memory.

After the video clip presentation, the instructor displays a diagram that illustrates basic computer components, which include the relationship between CPU and main memory. The instructor draws an additional freehand diagram and comments on it. Nick finds the importance of the capacity of main memory when a computer processes a large amount of data.

The basic scenario is a success story; at the same time, it functions as a problem scenario [11]. The instructor

analyzes it and assumes exceptional scenarios as follows. The exceptional scenarios are obtained using a claims analysis technique [2] or scenario-based inquiry.

**Exceptional Scenario 1 (Nick hesitates to interrupt):** Nick looks at a video clip that is projected on the front screen. He becomes interested in the topic of how a CPU processes data in its main memory. He does not grasp a clear idea of how the CPU interfaces with its main memory, but he feels that he does not want to disturb the class while the video clip is showing. Instead, he uses the PC on his desk and seeks the answer himself. He focuses on searching for the answer himself. For that reason, he misses the discussion following the video clip. Eventually, he becomes unable to understand the remainder of the class.

**Exceptional Scenario 2 (Nick has an advanced question):** Nick asks the instructor a question regarding the way in which a CPU processes data in amounts that are greater than its main memory size. The instructor has no pertinent diagram that explains this process. She tentatively combines two diagrams on main memory and a hard disk of computer, then explains the concept of virtual memory.

The instructor examines the exceptional scenarios to clarify the following claims.

- The characteristic and usage tip of the instructional material  $m_2$ : Video clip provides rich information to students, but may inhibit discussion among teachers and students when it plays.
- Students might have advanced and unexpected questions.

The scenarios provide mental preparation for the instructor. In this sense, the scenario used in the planning phase works as that for strategic planning [13]. Examining the claims and scenarios, for example, the instructor works further on an additional instructional material ( $m_a$ ), which could be used for explaining the virtual memory concept. Now the instructional content would be the following sequence of instructional materials, where parentheses represent an alternative (see Figure 4).

**Instructional content after examining the advanced question claim:**  $c'(CS1024-1) = m_1, m_2, (m_a), m_3, m_4, m_5$

The reflective activity in the planning phase, with its scenarios and claims, provides the instructor mental preparation for and flexible attitudes to the class.

However, it is impossible to envision all possible exceptions and prepare for them before the class session. Therefore, instructors must modify instructional contents during class activities when unexpected events occur in class. This situation indicates the internal loop of the double loop model, an iterative cycle of implementation, checking, and modification of instructional content.

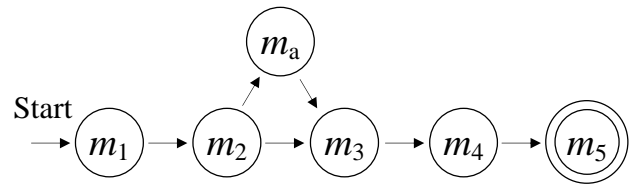


Figure 4. State chart representation of  $c'(CS1024-1)$ .

#### Apply phase

Apply phase is consisting of three phases: Implement, Check and Modify.

#### Implement phase

The instructor conducts the class in a classroom. The implementation phase consists of in-class teaching activities with instructional contents. In this example, the instructor manages the initial instructional content examined during the planning phase:  $c(CS1024-1)$ . She explains the day's agenda, shows the video clip, and so forth. She may use a computer tool that supports execution of the instructional content. Notwithstanding, the classroom is a dynamic environment. It always contains exceptional events. She needs to cope with unexpected events that occur in class.

#### Check phase

Unexpected events can be recognized if the instructor has a clear instructional content. In this example, she has  $c(1024-1)$  as the instructional content of the first class.

**Exceptional Scenario 3 (Printout does not come out):** Nick wants to print out the homework page of the course website displayed on his PC screen. He sends a printout command and goes to pick up the printout to the printer, located at the rear corner of the computer lab. He is unable to locate his printout, so he returns to his desk and sends a printout command again. Once again, he visits the printer, but he is not able to locate his printout. Nick starts thinking that either he should send a printout command again or ask for help from the instructor.

This is an unexpected error scenario that occurs in the class. The instructor must cope with the error context. She helps to solve Nick's printer problem and reports it to other students in the classroom because they might have a similar, or even identical, problem.

#### Modify phase

The instructor resolves unexpected situations in class to adjust the instructional content or create instructional materials if necessary. For instance, the instructor seeks appropriate documents in a database and combines them to show it to students. The following scenario illustrates this situation.

**Exceptional Scenario 4 (Printer runs out of paper):** The instructor notices that Nick might have a printer problem. After observing some of Nick's trials, the instructor confirms that the printer has no hardware problems. She

finds that the printer has run out of paper. As she refills the printer with paper, it prints out several copies of Nick's printouts. She decides to explain tips of printer usage to all the students in class. She searches for a web page of printer information from the computer lab's website, shows the page on the front screen, and explains how students should use the printer appropriately.

This unexpected scenario occurs in class. Therefore, if we assign  $m_b$  to the web page of printer tips, the actual implemented instructional content is as follows (see Figure 5 as well).

**Implemented instructional content:**  $c_{\text{result}}(\text{CS1024-1}) = m_1, m_2, m_a, m_3, m_4, m_b, m_5$



Figure 5. State chart representation of  $c_{\text{result}}(\text{CS1024-1})$ .

### Evaluate phase

The instructor conducts a summative evaluation of the planned instructional content and the resultant instructional content, which is obtained through execution of the internal loop of the double loop model. In addition, the instructor conducts a formative evaluation of the instructional content through reflection of all activities performed in the process.

In this example, the instructor compares  $c_{\text{result}}(\text{CS1024-1})$  with  $c(\text{CS1024-1})$  and examines how she would teach the instructional content of CS1024-1 in future class sessions.

### COMPUTING SUPPORT FOR DOUBLE LOOP MODEL

The above example leads us to consider two design issues to support activities in the double loop model: how to support formative evaluation during a class and how to record in-class actions and events to support summative evaluation after the class. To deal with the two issues, we designed and developed an interactive instruction system: IMPRESSION (Interactive Multimedia PREsentation System for Shared Instructional Objects on the Networks). It specifically intends to support teacher's activities in both Apply and Evaluate phase. In the following subsections, we describe the design of IMPRESSION and discuss its usefulness through the practical use of it in a living face-to-face class.

### Interactive Instruction System: IMPRESSION

The IMPRESSION system consists of instructor's terminal, student's terminal and lecture server as shown in Figure 6. The system software running on the instructor's terminal and the student's terminal is coded in MS VisualBasic .NET 2003 on Windows XP. Each terminal can import shared multimedia educational materials (e.g., picture, diagram, graph, slide-sheet, video-clip, animation, and web page) from public web servers on the Internet.

The server software running on the lecture server is coded Java2SE running on Solaris 8.

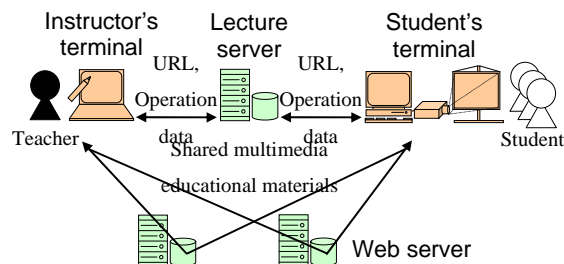


Figure 6. IMPRESSION system structure.

Figure 7 shows a GUI snapshot of the instructor's terminal. With the instructor's terminal, the teacher can incorporate any multimedia materials from web servers. This can be done anytime: before and after class, and during the class as well. During the class, while responding to student's question, the teacher can select and present appropriate materials from the registered ones to the main display, draw annotations on them, and turn over the slide-sheets sequentially one by one on the display.

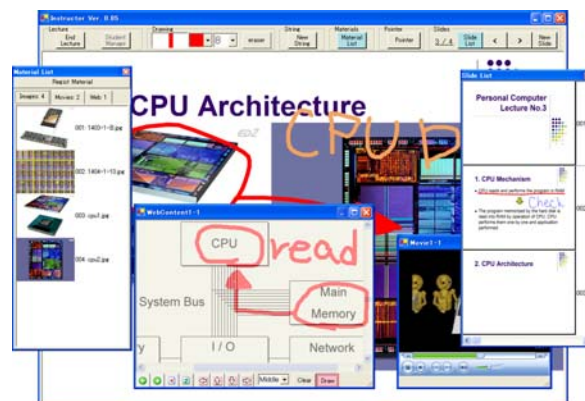


Figure 7. GUI Snapshot of the instructor's terminal.

As the teacher operates the instructor's terminal, both URLs of the used materials and the operation data are transmitted to the student's terminal. It captures materials from the specified web servers and executes operations for them based on the transmitted data. In other words, the data and operations on the instructor's terminal synchronize with the student's terminal. Therefore, the students can participate in the class watching the same screen as on the instructor's terminal and student's terminal. With the student's terminal, the students can operate the displayed materials and draw annotation on it.

After the class, the URLs and operation data are recorded and stored onto the lecture server. The data format is based on XML (see Figure 9). With the lecture data, each terminal can receive used material from the web servers, execute

operations one by one, and reproduce and replay the class data along with timeline after the class. In addition to the function, the instructor's terminal can record the whole scene of the class using microphone and digital video camera connected to the terminal. The function provide us to record the participant's voice and motion during the class and add links from them to the lecture materials used. The whole set of data can be run anytime after the class.

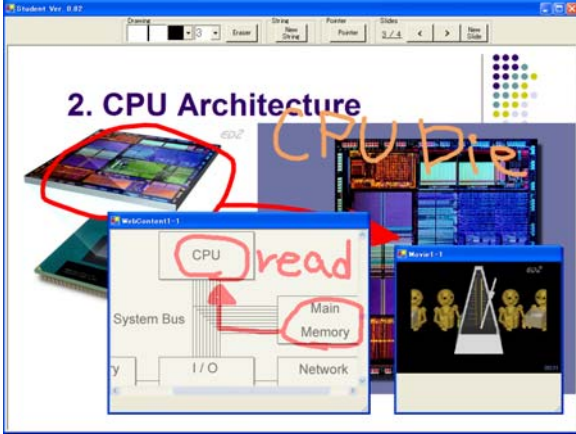


Figure 8. GUI snapshot of the student's terminal.

```
<?xml version="1.0" encoding="UTF-8"?>
<lecture>
  <material>
    <define id="Image1" url="http://www.istu.jp/cpu.jpg" />
    <define id="Movie1" url="http://www.istu.jp/program.mpg" />
    <define id="Web1" url="http://www.istu.jp/lesson-01.html" />
    <define id="Slide1" url="http://www.istu.jp/slide-01.png" />
  </material>
  <start data="2005/09/16/16:13:16" />
  <operate time="1162">
    <present id="Image1-1" form x="192" y="-108" />
  </operate>
  <operate time="1680">
    <movie id="Movie1-1">
      <seek time="36.2179832" />
    </movie>
  </operate>
  <draw time="1837">
    <line id="Web1-1" color="#FFFF0000" width="3">
      <point x="332" y="111" />
      <point x="333" y="113" />
      <point x="453" y="573" />
    </line>
  </draw>
  <end date="2005/09/16/17:16:27" />
</lecture>
```

Figure 9. Example of generated lecture data.

In summary, the IMPRESSION system allows teacher to leverage timely multimedia data during the class. The teacher can react quickly and effectively to the modification of an instructional plan based on formative evaluation in class. Moreover, the teacher can conduct summative evaluation after class, and the students can run the class data to review the class.

## EXPERIMENT IN A LIVING CLASS

In order to confirm the validity of our framework, we tested our developed IMPRESSION in a living face-to-face class and collected participants' comments.

The class is conducted under the context of a high school-university cooperative project, which assumes using a large scale physics experiment facility installed at Engineering Department at a National University. The topics treated in the class contain the atom, the ion, dynamics, electromagnetisms, and the radiations. Generally in high school, these topics are discussed in a separate class; therefore, it is difficult for students to gain a better comprehension of the subjects' concept only with ordinary regular classes. Because it is a newly established project, the project members (i.e., teachers, professors, and teaching assistants) considered it difficult to prepare a complete content set of its educational materials beforehand. Therefore, they decided to design the class as a discussion class: the class has progressed while asking some questions to the student promptly to check on the students' comprehension level of the subject and modify its instructional plan during the class. For this purpose, they employed our framework to understand the whole project course and used IMPRESSION as a core tool to support classroom activities.

### Outline of the Experiment

The project used IMPRESSION at a face-to-face class, in which a teacher, two teaching assistants (TAs), and twenty eight high school students participated.

The IMPRESSION system used in the class consists from instructor's terminal and student's terminal. Instructor's terminal has the large-screen display with a handwriting facility. Student's terminal uses the large-sized screen set on the front wall in the classroom, which displays an image presented from the ceiling projector.

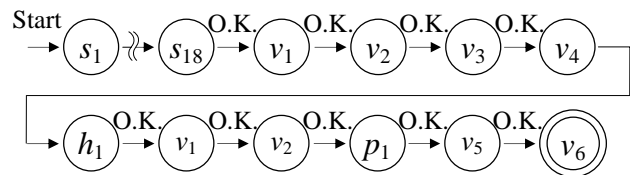


Figure 10. Planned state transition diagram for the living project.

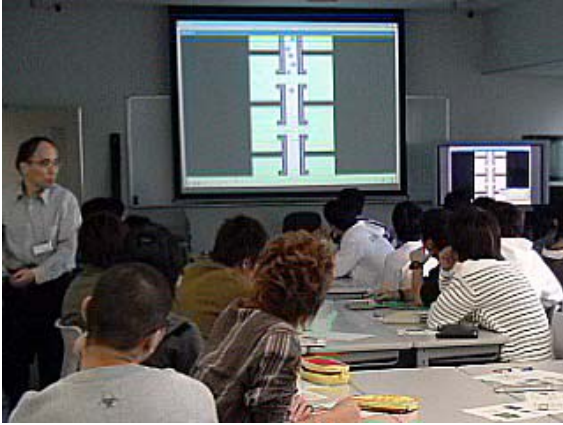
Figure 10 depicts the planned state transition diagram based on the instructional scenario (Nick's scenario). The types of state labels are summarized in Table 2. At the beginning of the class, the teacher presented some materials in slide-sheet form, showing agenda and topics; then, he started the discussion in class by answering to students' questions while presenting materials in picture and video-clip form.



Label	Detail
$h_n$	Instruction by handwriting
$p_n$	Instruction using photo, picture, or diagram
$s_n$	Instruction using a slide-sheet created by presentation tool such as MS PowerPoint
$v_n$	Explanation with video-clip playing
$w_n$	Explanation with web browser showing web pages

**Table 2. Types of instruction action.**

Figure 11 and 12 shows scenes from the living class. In Figure 11, the teacher standing at the left side is presenting video-clip material and explaining to answer the students' questions with the IMPRESSION system. In Figure 12, the teacher draws annotations on the presented picture material.



**Figure 11. A classroom view with the IMPRESSION system.**

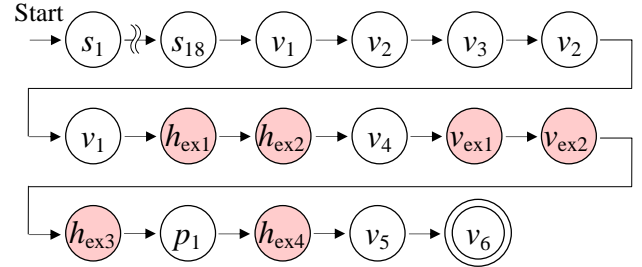


**Figure 12. A classroom view: the teacher drawing an annotation on screen.**

#### Outcome of the Experiment

Figure 13 illustrates the implemented sequence of the instructional acts in the class. In Figure 13, each suffix ex

represents that they are not planned instructional actions before the class and newly added act during the class. Table 3 summarizes prepared, added, and used instructional materials in the class. We prepared not only materials needed in the instructional actions in Figure 10 but also many other materials shown in Table 3.



**Figure 13. Implemented sequence of the instructional acts in the project.**

Materials	Picture	Video	Web	Slide	Total
Prepared	22	11	1	19	53
Added	0	2	0	0	2
Used	1	8	0	18	27

**Table 3. Summary of instructional materials in the class.**

After the class, we asked the students to fill out questionnaires and collected twenty four responses. Figure 14 summarizes part of the responses. Similarly, we asked the teacher and TAs to fill out the survey on the functions of IMPRESSION and collected 3 answers. Table 4 shows a summary of the comments from the teacher and TAs. Basically, they made very favorable comments on the use of IMPRESSION.

After the class, furthermore, we planned an instructional scenario for the future classes according to the result of summative evaluation based on both planned action (Figure 10) and the implemented action (Figure 13). For example, first, we replaced handwriting explanation  $h_{ex1}$  with slide presentation  $s_{19}$  because in  $h_{ex1}$  the teacher drew a table. Next, we replaced  $v_{ex1}$  and  $v_{ex2}$  with  $v_7$  and  $v_8$  respectively because we expected that they are needed in future by summative evaluation. Finally, we considered that  $v_3$  require the understanding about  $v_1$  and  $v_2$ . Thus, we applied loop structure to them. Finally, we obtained the state transition diagram as shown in Figure 15.

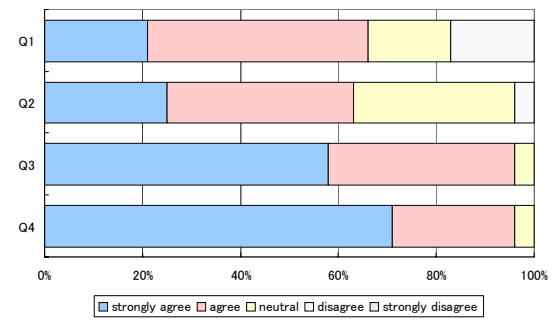
Function	Comments
Presentation	“Although we did not have a clear plan to use it, we were able to show the materials properly during the class.”  “Its advantage is the ability to use different media form depending on situation.”
Handwriting	“We were able to encourage the students by drawing annotations directly on the materials.”  “It is extremely easy to edit and/or add annotations immediately.”
Slide	“It is very convenient when creating the story of class progress.”
Pointer	“It would be easier if we were able to switch to the pointer easily.”  “It would be more convenient with functions that allow us to change the pointer size.”

**Table 4. Summary of the teacher and TAs’ comments.**

#### Usability of IMPRESSION in Class

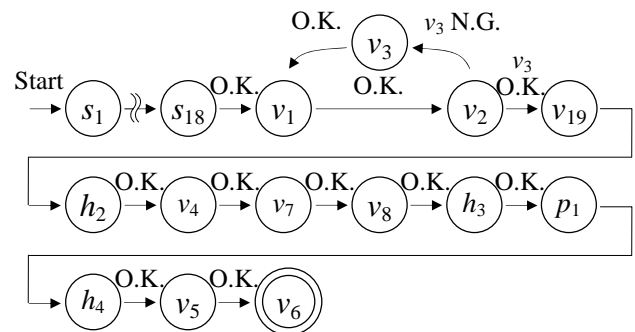
The students’ responses confirmed that the use of IMPRESSION is acceptable. The educational materials and drawings were clear on the screen of IMPRESSION. We had favorable comments on the system such that “because the operation time to draw or erase was short, we did not waste our time in class” and “the drawings, the picture, and the animation were clearly seen on the same front screen, and it was comprehensible.” In brief, the use of IMPRESSION contributes to students’ understanding of the class content.

The responses from the teacher and TAs reveal usability problems of IMPRESSION specifically on the pointer function; however, we generally received favorable comments such that “it is easy to do explanation while presenting materials or drawing annotations” and “it is flexible to progress the class to present materials, which were not planned to present when the scenario planned.” These comments were given from the fact that the teacher can change the presentation order of materials. In addition, the teacher can add an instructional action using new materials registered during the class by comparing the planned state transition diagram (Figure 10) and the implemented sequence of the instructional actions (Figure 13). IMPRESSION offers advantages in such a class where the teacher presents suitable educational materials, draws annotation on them, turns over slide-sheets and so on at the right time according to the reactions of the students during the class.



Q1: The timing has no gap between oral explanation and screen presentation  
Q2: It is clear for the student where on the screen the teacher is talking about  
Q3: I is helpful the class to understand using handwriting explanations  
Q4: It is helpful for the class to understand using multimedia materials

**Figure 14. The students’ responses from the project.**



**Figure 15. Example of a planned state transition diagram for the next future classes.**

#### CONCLUSION

This paper discussed the double loop model of scenario-based instructional design and implementation. It illustrated the model using an example and explained our instruction system IMPRESSION, which supports part of the model. The use of IMPRESSION in a living class confirms that it supports formative evaluation in class and summative evaluation after class.

The major contribution of this project is to provide a framework of instructional design and implementation including a formal definition of scenario. In addition, it is to show a tool to support activities in the model. Current limitation of the tool is that it focuses mainly on the Apply phase of the double loop model. We are extending the tool for creating or editing instructional scenario and state transition diagram in Plan phase, checking and modifying these ones during a class in Apply phase, or comparison with planned ones and implemented ones to make indicator for redesigning automatically in Evaluate phase.



## REFERENCES

1. Abowd, G.D. Classroom 2000: An experiment with the instrumentation of a living educational environment. *IBM Systems Journal*, 38, 4 (1999) 508-530.
2. Carroll, J.M. *Scenario-Based Design of Human-Computer Interactions*, MIT Press, Boston, MA, 2000.
3. Carroll, J.M. (Ed.). *HCI Models, Theories, and Frameworks: Toward a Multidisciplinary Science*, Morgan Kaufmann, San Francisco, CA, 2003.
4. Dick, W. and Carey, L. *The systematic design of instruction*. Scott, Foresman, Glenview, IL, 1978.
5. Gagne, R. and Briggs, L. *Principles of Instructional Design*. Holt, Rinehart and Winston, New York, 1974.
6. Go, K. and Carroll, J.M. The blind men and the elephant: views of scenario-based system design. *interactions* 11, 6 (2004), 44-53.
7. He, A. RIDEE: A Realtime and Interactive Distance Education Support System. *Proc. 17th International Conference on Advanced Information Networking and Applications* (2003) 775-781.
8. Keller, J.M. Motivational design of instruction. In C.M. Reigeluth (Ed.). *Instructional design theories and models: An overview of their current status*. Hillsdale, NJ: Erlbaum (1983).
9. Lee, W.W. and Owens, D.L. *Multimedia-Based Instructional Design: Computer-Based Training, Web-Based Training, and Distance Learning*. Pfeiffer (2000).
10. Nakabayashi, K., Maruyama, M., Koike, Y., Kato, Y., Touhei, H. and Fukuhara, Y. Architecture of an Intelligent Tutoring System on the WWW, *Artificial Intelligence in Education (AI-ED'97)*, (1997) 39-46, IOS Press.
11. Rosson, M.B. and Carroll, J.M. *Usability Engineering: Scenario-Based Development of Human-Computer Interaction*. Morgan Kaufmann, San Francisco, CA, 2002.
12. Sutcliffe, A.G. and Carroll, J.M. Designing claims for reuse in interactive systems design. *International Journal of Human-Computer Studies* 50, 3 (1999) 213-241.
13. Wack, P. Scenarios: Uncharted Waters Ahead, *Harvard Business Review*, September/October, (1985) 73-89.