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Two Symbol Systems for Designing Instructional Processes

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Two symbol systems for designing classroom teaching are proposed and the results of their application in preparing lesson plans are shown in this paper. The traditional lesson plan does not include a rational description of actual instructional events and corresponding behaviors of learners in the classroom. New symbols have been developed with the intent of relating predicted descriptions to actual events observed in the classroom, and of facilitating the generation of lesson plans and the production of teaching materials. One system of symbols is for describing general instruction and the other is specifically for science teaching. For instruction of large classes, lesson plans were easily generated by teachers working in groups with role-playing in simulated situations. After the actual classroom teaching, the lesson plans were revised in accordance with the responses of the learners. For instruction of small groups, science teaching using experimental equipment was easily designed using these symbols. Utilization of these symbols was beneficial in the following ways: (1) to describe mutual relationships of events in classroom teaching, (2) To facilitate revision of lesson plans, (3) to design conceptually instructional processes by manipulating the symbols which are packaged into a job-aid kit. On the other hand, systematic training of teachers is indispensable in order to specify the relationships between the symbols and their referents.

BACKGROUND

Teacher performance in the classroom is usually guided by lesson plans carefully prepared in advance. Instructional aims, prior knowledge of the pupils in the classroom, and other critical factors affecting the instructional outcomes are taken into account when preparing the lesson plan. Those who intend to produce instructional materials, while referring to techniques of programmed instruction and educational technology, proceed in a systematic sequence of specific techniques, such as specification of instructional objectives, task analysis, frame writing, etc. Such skill-required techniques are selected from the teachers competency repertory and arranged into a sequence according to their instructional strategies. Among these, methods of stating instructional aims in specific ways have been well studied (Mager, 1962; Gronlund, 1970; Bloom et al., 1971), and specification of instructional objectives using behavioral terms has been widely adopted among teachers as a procedure for writing lesson plans.

Sequencing of teaching points is a widely discussed issue among specialists of instructional design. Several methods have been proposed, such as Logical Sequence, RULEG, EGRULE, Backward Fading of Chain, Thoughtful Arrangement of Association and Discrimination, etc. In spite of these various propositions, there is no evidence to support the superiority of one specific technique over the others. If the procedures for these techniques were explicitly stated, they could be easily followed by other specialists. Then, when following these techniques in producing instructional materials, the absence of a critical technique among those well-established ones accumulated and used during past production of materials to express one's own experiences would be noticed. A job-aid for facilitating the description of instructional sequences must be developed so that we may determine sequences while referring to our own experiences in instructional design.

In the traditional form of lesson plans, we find instructional aims, evaluation points, and a sequence of teaching points. But the arrangement of instructional events is decided at the teacher's option and the functional relationships between teaching-learning events are not stated explicitly. This ignoring of the mutual points of correspondence between teacher's intentions and instructional realities results in difficulties in systematic improvement of lesson plans, which must be done by taking the instructional events observed in actual teaching into account.

RATIONALE

The purpose of this study is to develop job-aids for facilitating the designing of teaching-learning processes, the producing of instructional materials, and the mutual transferring of teaching experiences between instructors. The possibility of training in-service and pre-service teachers to make proper use of the job-aids developed and to express their predicted processes of instruction are also discussed in this paper.

This idea of developing a symbol system for instructional design was suggested mainly by two conceptual frameworks: simulation of the teaching-learning process and the communicability of messages through the use of symbols. The concept of simulation is widely employed in various fields, such as science, economy, sociology, technology, etc. The possibility of adopting this idea in education has been discussed and studied by many researchers: P.J. Tansey (1971), H. Azuma (1972), J. Bloomer (1973), and G.I. Gibbs (1975). The possibility of adopting the conceptual model of simulation into designing procedures for instruction has already been suggested by one of the authors with the intent of facilitating a systematic and continuous improvement of lesson plans prepared by teachers (Nishinosono and Nagano, 1974; Nishinosono, 1975). A lesson plan can be called a description of predicted instructional events expected to emerge in actual teaching. When designing the teaching-learning process, the functional relationships between teaching and learning events observed in the classroom should be taken into consideration. Predictions of instructional processes may be selected by referring to one's knowledge of instructional science, the experiences of teachers with long careers in teaching, or the suggestions of other experienced colleagues.

Designing instruction is, in other words, a process of predicting a sequence of teacher's and learners' performances, including covert behaviors. When teachers participate in a game for the design of a teaching-learning process, it may be assumed that it is a process of simulating teaching-learning events. The method of describing such predictions should be in the form of a schematic model using symbols rather than that

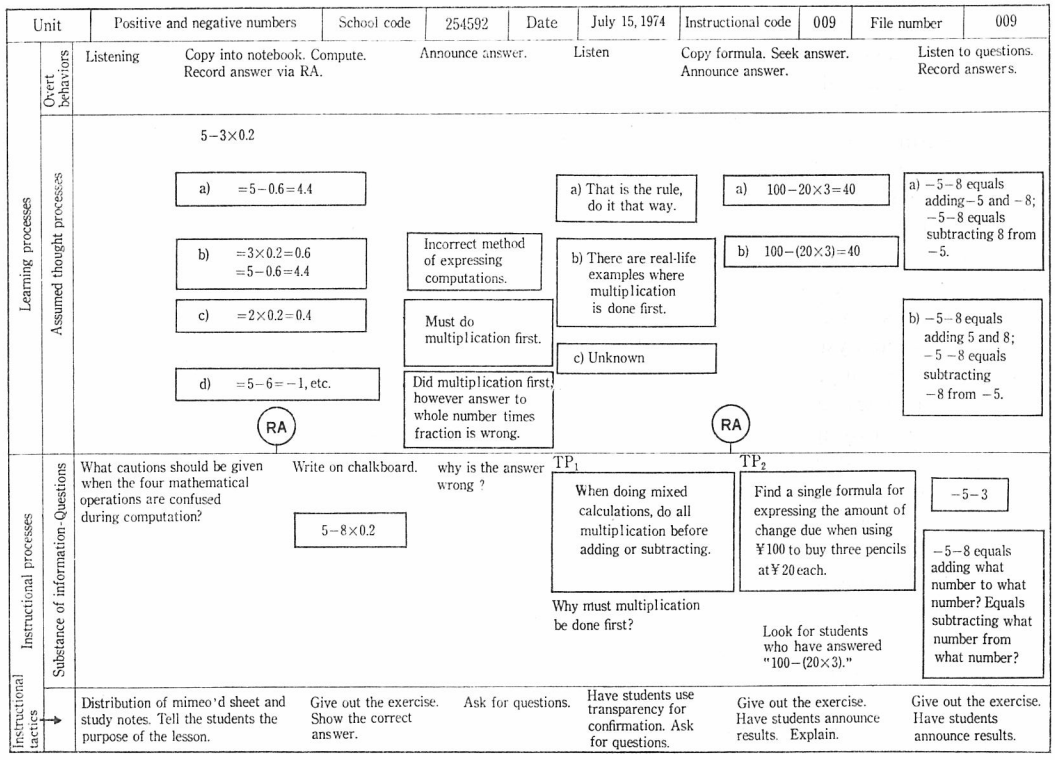

Fig. 1. Revised lesson plan—Case I.

of a metric model using mathematical functions because it is expected that the descriptions of predicted relationships will be used as a lesson plan by the teacher in his classroom. The sequences of events described in the game are called "Map of Instructional Processes" or MIP.

This simulation, as a method of designing instructional sequences, may be categorized as a kind of cooperative simulation game in which the teachers take the roles of learners, participate cooperatively, and simulate the teaching-learning process. The MIP generated as an outcome of the gaming is considered to have a function similar to that of wiring diagrams or road maps which give electricians or drivers a preview of the sequency of their tasks (Pailhous, 1969). This type of simulation is classified in the category of stylized simulation (Tansey, 1971). An MIP is expected to give a teacher a forecast of the instructional process and the mental set for teaching.

The MIP is composed of two major processes: the teaching process and the learning process. The teaching process includes three aspects of teaching: information given to learners, instruments or equipment provided, and instructional tactics performed by the instructor. Instructional tactics consist of planned tactics and responsive tactics (Strasser, 1967). But, in the MIP, only a simplified description of planned tactics is developed in the column of teaching activities shown in Fig. 1. The learning process is assumed to be composed of both unobservable or covert behavioral as well as observable or overt behavioral learning activities.

Several systems of task taxonomy have already been proposed for the identification of teaching and learning activities. Task taxonomy is expected, particularly, to give insights to instructional planners and programmers on strategies regarding instructional tactics. However some of them are stated in psychological terms which are unfamiliar to in-service teachers. This makes it difficult for teachers to grasp the basic elements of the learning events and prepare their own sequences of teaching tactics. It is intended to describe these conceptual components of instruction mainly in the form of the symbols to be discussed later.

In simulation gaming played by in-service teachers for the generation of lesson plans, the teachers are requested to relate the symbols provided by the authors to the actual events or phenomena arising in instruction. After the relationships of the symbols and actual events are understood, the teachers are requested to manipulate the symbols to express their own concepts for a plan of instruction, while taking the functional relationships of teaching and learning into account. There very likely are limitations to the

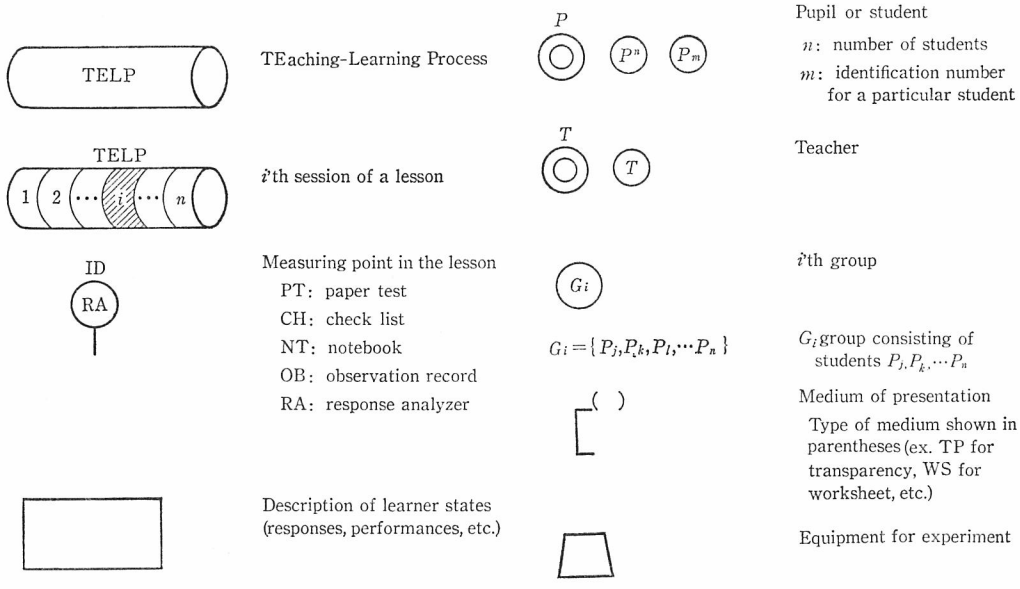

Fig. 2. Symbol system for the design of the teaching-learning process (STELP-74) designed by H. Nishinosono.

feasibility of using these symbols in expressing predictions concerning teaching-learning activities. But in spite of these limitations, a skeleton of the instructional process can be described in a lesson plan in the form of a stylized simulation composed of short statements and symbols.

APPLICATION OF PRINCIPLES

Two systems of instructional symbols have been proposed: one in 1974 by Nishinosono (Nishinosono and Nagano, 1974), the other in 1975 by Hino, Fujita and Nishinosono (Nishinosono, 1977).

The system given in Fig. 2 is composed of the teaching-learning process, indicators for the assessment of learning, short statements about the learners' states, the learner, the teachers, groups of learners, the media for presentation of information, and the equipment for science experiments. This system was named STELP-74 (Symbol system for the design of a TEaching Learning Process-1974).

The second system of symbols, developed in 1975, is composed of about 70 symbols which are given in the appendix at the end of this paper. This system was combined with the STELP-74 and named the STELP-75 SCIENCE EXPERIMENT, because these symbols are used together in the design of science teaching, especially teaching which includes scientific experiments as part of the learning process.

Three case studies on adopting these symbol systems for the designing of instructional processes are given in this paper. The first study is simulation gaming performed by a group of math teachers using the STELP-74. The second study is an MIP prepared for science teaching by an in-service teacher. The third study is also an MIP, revised by the same teacher as in the second study, using the STELP-75 SCIENCE EXPERIMENT.

Case I

Lesson plans are usually prepared by the teacher who is going to give the instruction. The format of the traditional lesson plan is convenient for the teacher to develop ideas for instruction which he, himself, is to conduct and which do not, however, exert any influence on his colleagues. Individual and isolated writing of lesson plans hampers the effective exchange of ideas and teaching experiences among teachers.

The traditional lesson plan widely used in

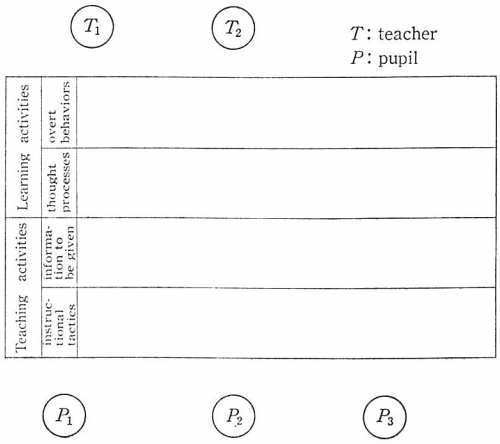

Fig. 3. Framework for simulation gaming of instructional design.

Japan tends to cause the teacher to write a teacher-dominated instructional unit. This is because, in the lesson plan, the teacher's activities start first and the learners' activities follow. With the intent of gradually orientating the teachers towards preparing learner-centered instructional units, as a first step, we used the traditional way of designing instruction but employed the STELP-74 symbol system to describe the lesson plan.

Four or five teachers in a group participated in simulation gaming as developed by Nishinosono for the design of a teaching-learning process (Nishinosono and Nagano, 1974). They sat around a desk which was covered with a large sheet of paper as shown in Fig. 3. Two of them played the roles of teachers who determined instructional strategies and tactics. The others took the roles of learners, assuming they were pupils studying in a class, who responded to the teachers' actions. Before starting the game, the conceptual model of the teaching-learning process was explained (Fig. 4). The process is assumed to consist of five parts:

(1) Assumed thought processes and covert behaviors of pupils.
(2) Predicted overt behaviors of pupils.
(3) Intentions and decisions of the teacher.
(4) Instructional tactics and actions taken by the teacher.
(5) Information to be given and the learning environment to be provided.

Pupils are supposedly transformed by the effects of instruction. The process of this transformation and the learning states of the pupils at

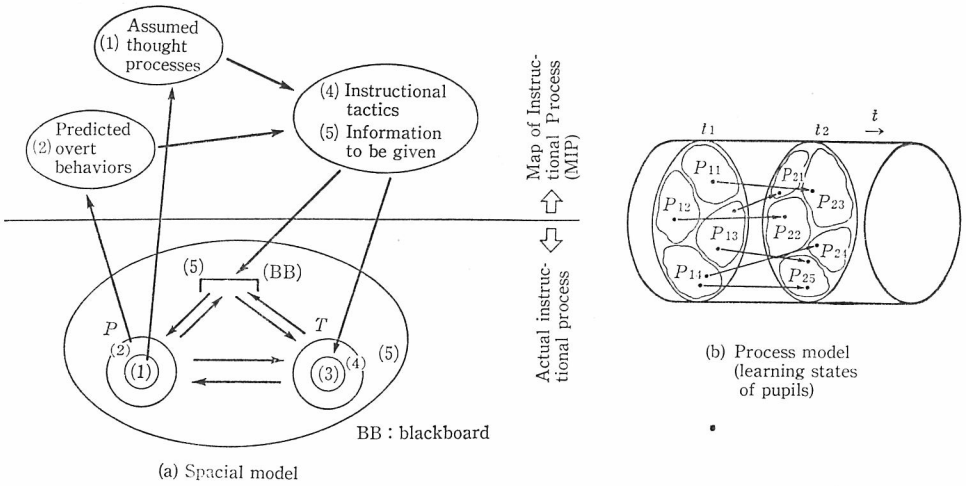

Fig. 4. Schematic model for the design of the teaching-learning process.

every moment in the process are illustrated in Fig. 3(b), where P_{ij} shows the pupils in a learning state j as of moment t_i. The process of transformation of any one pupil can be described as the sequence of P_{ij}.

At the beginning of the game the participants were requested to determine instructional objectives, subject matter content, and criterion-referenced test items. The following precautions were also given:

(1) "Teachers" and "pupils" are permitted to communicate only with players taking similar roles. They could not communicate with those taking opposite roles. Communication between teachers and pupils could take place only through written comments on small sheets of paper.

(2) "Pupils" write assumed performances and responses to the learning activities and show them to the "teachers" who decide instructional strategy, select tactics and write instructions to be shown to the "pupils."

(3) It is advisable that the "pupils" initiate the gaming, but when this is difficult the "teachers" may take the initiative.

(4) After the first section of the gaming is completed, all players discuss the conditions of gaming and decide whether they will continue or repeat from the beginning.

(5) If time allows, participants change roles and repeat the gaming.

(6) It is advisable that, in the first gaming, participants with long careers in teaching take parts of the "pupils."

Actual teaching in a classroom was implemented after the gaming. A teacher who had participated took responsibility for implementation in accordance with the process of the lesson plan generated as a result of the game. After actual classroom use, the participating teachers revised the lesson plan, analyzing and taking into account the results of the teaching. A revised lesson plan, as shown in Fig. 1, was thus obtained.

Case II

It is often observed that when placed in a small group some pupils have difficulty participating actively in the group's learning process. Some pupils participate lively in the learning but others hesitate to show any interest in it. With the intent of lessening such unfavorable hesitation, the STELP-74 symbol system was examined as to its feasibility as a tool for designing favorable small group instruction.

An in-service teacher was requested to design instruction for four 5th grade elementary school pupils who were learning science and which included an experiment as part of the instruction. The teacher specified his instructional aims in terms of behavioral objectives and determined his strategy of instruction. He prepared overhead projector transparencies, work sheets, guide sheets for the experiment, and the equipment needed to conduct the experiment (Fig. 5).

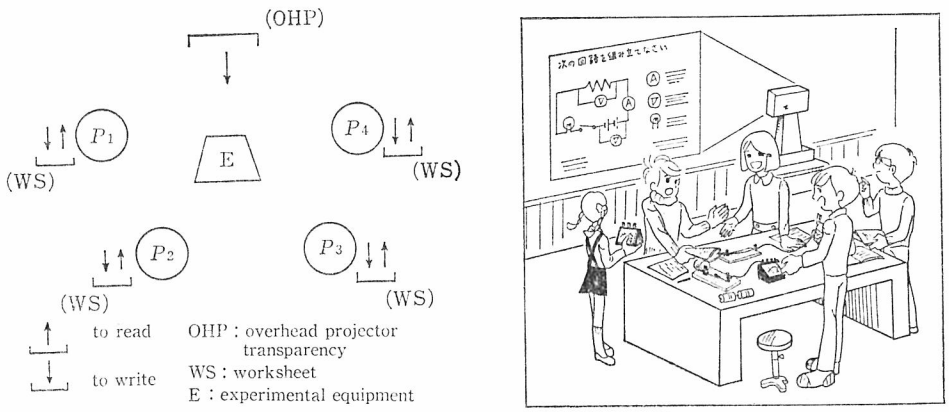

Fig. 5. Schematic model for design of small group learning which includes experiments.

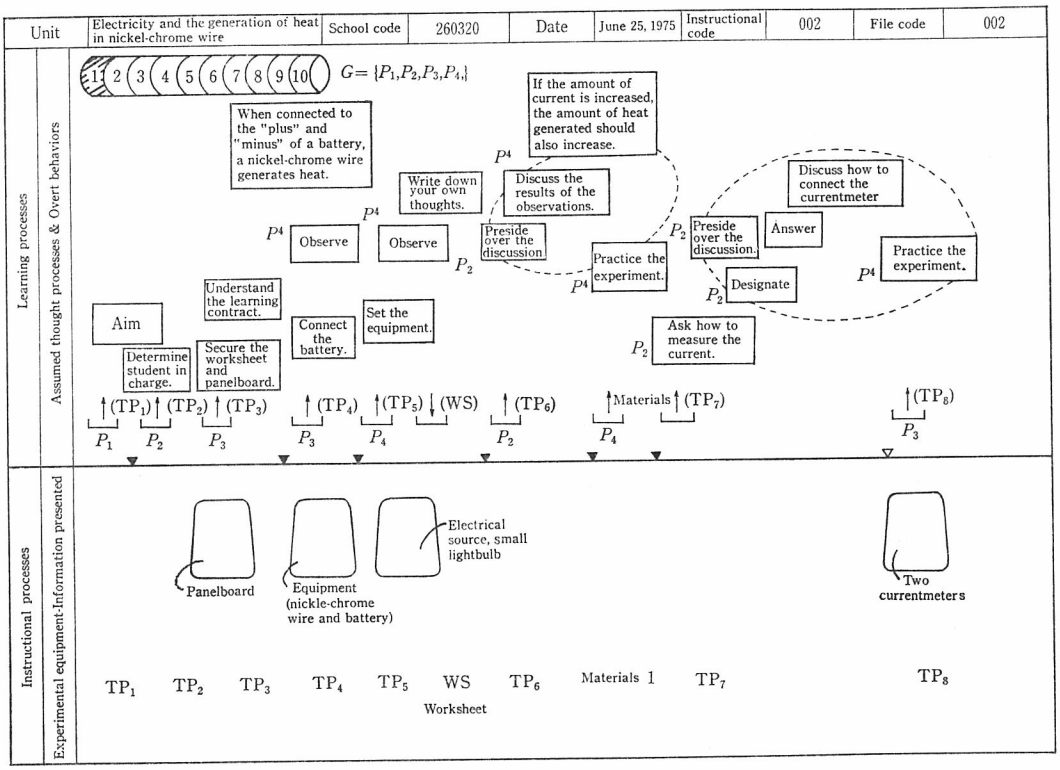

Fig. 6. Revised lesson plan—Case II.

The instruction was then implemented, the four pupils being guided only by the instructional materials and not given any direct teaching. The teacher observed the learning process and also recorded it by VTR. The process was analyzed in full detail in order that the critical points could be made clear for future rational revision of the lesson plan. The STELP-74 symbol system was necessary in analyzing the instructional process, to identify the learners, and to notate utilization of media. The revised lesson plan in the form of an MIP is shown in Fig. 6.

In this lesson plan, the pupils are designated by the symbol P_i, which means the i'th pupil of n number of pupils. P^n, of course, means that n number of pupils worked together on a specific

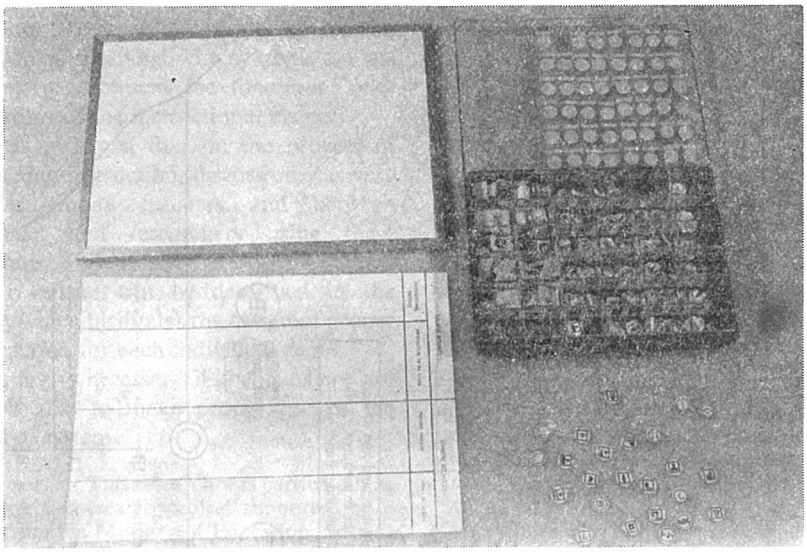

Fig. 7. Job-aid kit.

task. The blocks encircled by dotted lines show the pupils group activities. The pupils who read the work sheets or overhead projector transparencies are indicated in the MIP, because in this instruction, even a slow and timid learner was expected to participate actively. The roles had been designed in advance by the teacher to make clear the participation points of the slow child.

Case III

The same teacher who participated in Case II was requested to conceptually generate an MIP using the STELP-75 SCIENCE EXPERIMENT symbol system which includes about 70 symbols for the representation of experimental tasks.

The teacher was provided with a job-aid kit to help in the instructional design. It included the new symbols on 15mm diameter steel discs and a magnetic board upon which the symbols could be placed, manipulated and re-ordered into an MIP format (Fig. 7). The resulting MIP was copied and used as a lesson plan in actual classroom instruction. An example of this lesson plan is shown in Fig. 8.

CONCLUSION

Two symbol systems were examined in this study: the STELP-74 and the STELP-75 SCIENCE EXPERIMENT. The first is composed of nine different symbols which represent essential, indispensable components of the teaching-learning process. This system was used in Cases I and II to examine its feasibility in describing the instructional process. In Case I, the symbols were not used fully, but an attempt was made to transform the teachers' mental sets concerning the instructional process by using simulation gaming. Case II shows that the STELP-74 symbol system can be used, not only to present a spatial model for small group learning (Fig. 5), but also that the resulting MIP can be used as a lesson plan in classroom teaching (Fig. 6). It was found that MIP can be easily and systematically revised with respect to the results of an analysis of the events observed during actual instruction.

In Case III, the STELP-75 SCIENCE EXPERIMENT symbol system was studied as to its feasibility in designing small group learning which included a scientific experiment. Because of the experiences gathered in conducting Cases I and II, there was no difficult in using the symbols to describe the learning situation and instructional process.

The following are the conclusions regarding the feasibility of these two symbol systems:

(1) A lesson plan can be described in the form of a prediction of instructional events and the MIP can be considered as a means of hypothesis formation for the teaching-learning process.

(2) The MIP can be revised taking into

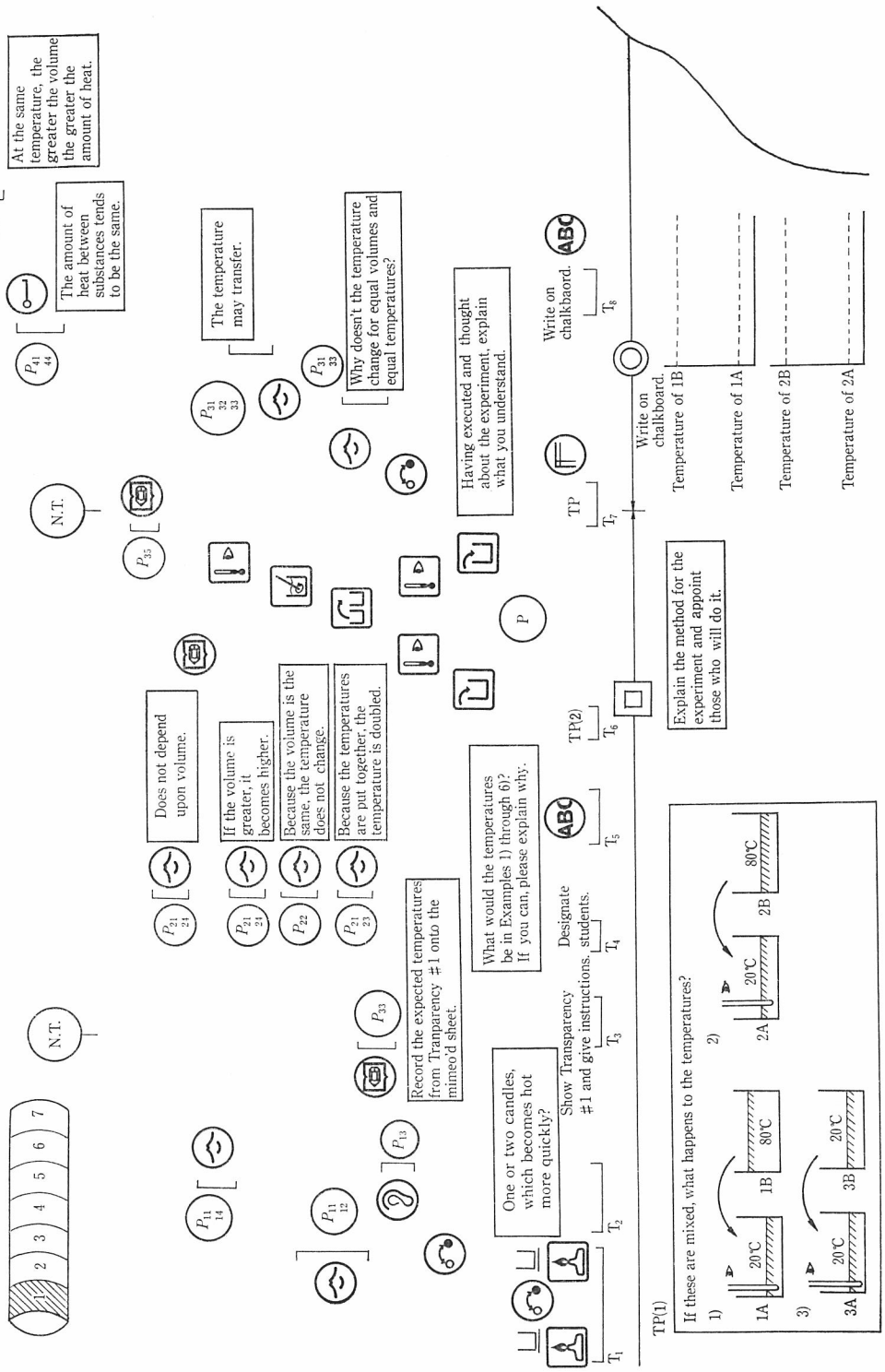

Fig. 8. Sample lesson plan—Case III.

account the analyzed results of the implemented teaching. The symbols are assumed to represent the functional relationships of the instructional events.

(3) It was observed that, in the process of designing instruction, discussion was very active among teachers and between teachers and researchers using these symbols.

(4) Each learner can be described in the MIP, which facilitates the design of proper instruction for each individual pupil.

(5) Training is necessary if the teachers are to be able to make proper use of the symbol systems.

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APPENDIX

Activities for Estimating and Collecting Information

Area	Item	Meaning	Code	Symbol
Estimating and Planning		Estimating	1	
		Assuming	2	
		Planning	3	
Transfering Information	Acceptance	Listening	10	
	Transmission	Announcing	11	
		Discussing	12	

Activities for Dealing with Results

Area	Item	Meaning	Code	Symbol
Handling Results	Data Collection	Observing	20	
		Using a Microscope	21	
		Taking Notes	22	
	Data Analysis	Comparing	30	
		Classifying	31	
	Expressing Results	Letters	40	ABC
		Numerals	41	1+2=
		Table	42	
		Graph	43	
		Model	44	

Activities Performed during Experiments

Area	Meaning	Code	Symbol
Preparation	Preparing Items	50	
	Assembling	51	
	Disassembling	52	

Area	Item	Meaning	Code	Symbol
Basic Operations	Simple Operations	Taking	60	
		Holding	61	
		Shaking	62	
		Tipping	63	
		Pushing	64	
		Pulling	65	
		Cutting	66	
	Moving Items	Putting Down	70	
		Putting Closer	71	
		Putting Apart	72	
		Uniting	73	
		Sliding	74	
		Passing Through	75	
		Closing	76	
		Covering	77	
		Uncovering	78	
		Corking	79-a	
		Corking	79-b	
		Uncorking	80-a	
		Uncorking	80-b	
	Moving Contents	Putting In	81	
		Taking Out	82	
		Adding	83	
		Removing	84	

Area	Item	Meaning	Code	Symbol
Treatments	Treating Liquids	Mixing	110	
		Melting	111	
		Precipitating	112	
		Filtering	113	
		Dropping	114	
		Soaking	115	
		Wetting	116	
	Treating with Heat	Igniting	120	
		Combusting	121	
		Heating	122	
		Evaporating	123	
		Drying Thoroughly	124	
		Drying	125	
		Cooling	126	
	Treating Gases	Collecting	130-a	
		Collecting	130-b	
		Smelling	131	
	Electric Conduction	Making a Circuit	140	
		Closing Circuit	141	
		Opening Circuit	142	
		Connecting	143	
		Rotating	144	
Measuring		Weighing	190	
		Measuring	191	
		Taking Temperature	192	
		Timing	193	
		Measuring Current	194	
		Measuring Voltage	195	
		Measuring Length	196	
		Measuring Strength	197	