

# An Action Research on System Dynamics Course Through Cooperative Learning

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## **Abstract**

We explore instructional design of system dynamics by action research in the recent years, improve the situation of teaching, learning, and practice constantly, and accumulate some knowledge and experience. This paper describes some teaching innovations by action research with three fundamental principles: (1) structure influences behavior, (2) set up the goal and feedback learning, (3) from easy to difficult. We want to design the curriculum from three dimensions: learning environment, process, and content. We acquired five conclusions with the impact of action research which intervened the activities of teaching by questionnaires in this paper: (1) the scope of system dynamics is quite broad, thus, teaching needs to be adjusted in accordance with various conditions. (2) cooperative learning can enhance learning results and learning enforcing. (3) action research will be a good guidance for teaching system dynamics through cooperative learning. (4) systems thinking and system dynamics are complementary. (5) instructional design must have systematic characteristics and be implemented step-by-step.

## **Keywords**

System Dynamics, Action Research, Cooperative Learning

## **Introduction**

Along with the technological advance, the current of thought of fragment makes its teachings greatly, students learn some fragmental knowledge at school. How to

teach students value the whole again is becoming more and more important. In Taiwan, professional is still an essential notion at present. Most of guidelines seemed to be replaced by profession. There will have a side effect to all society, which will lack for the view of entirety behind the professional. It is so difficult, if we want to change the thought of division in society. We only can do from education. If we hope students to understand, accept completely, and become a real learner, it maybe still difficult. It is a big topic and challenges that students can accept the systems education step by step and have interest.

Most of the traditional education of Chinese is the relation about teacher to student. Generally speaking, in Taiwan, teachers usually give content but are much less question or request students thinking actively. Consequently, students are usually short of reflection, and inquiry. Compare with west society, students in Taiwan often lack for spirit of active learning from their childhood. Either students usually obey their parents' request, or fear be eliminated by society. Some of the students do not know what they want, and just want to graduate. It is an ordeal for teachers that how to face these problems and disseminate knowledge further.

This research hopes to use cooperative learning by action research at the instruction of system dynamics. For one reason, we want to improve the passive learning situation and integrate accumulative experience and establish a framework amount teaching, learning and practice. For another, we emphasize the important of curriculum design, and encourage learning motive, and experience various systemic essence.

About improving students' passive learning, the influence of feudal society, so-called traditional education of Chinese in basic representation is spoon-feeding way, cramming, examination first. In this situation, students just represent negative and passive about their learning. Few of students can learn actively. Generally speaking, while teachers found students' learning not very well, they usually take some examination. Examinations can to get instant results, but if teachers only promote students' learning results by that, it will bring some side effects for a long time.

Johnson & Johnson (1986) emphasized that the truly learning would occur the following situations: 1. Learning only occurs on personal mental activities. 2. Nobody can acquire knowledge unless they believe they can learn. 3. Examinations are just being a feeble index. 4. Students interest in questions and the aspect of their interests. 5. The most plentiful activities are discovered by teachers. 6. It's important to choose a good instruction.

Teachers' work is to propagate doctrines of the ancient sages, to instruct peoples' studies, to answer their doubt. So, Instruction is teachers' unshirkable responsibility. We hope to involve students' participations, change their attitude and increase their learning motivation. Creating learning win-win through cooperative learning.

## Cooperative Learning

Cooperative learning is a systematic and structural teaching strategy. In cooperative learning class members are split into small groups. Slavin (1995) refers that variety of teaching methods in which students work in small groups to help each one another learn academic content. Students need to learn to think, to solve problems, and to integrate and apply knowledge and skills.

Johnson & Johnson (1994) give a definition about cooperative learning: Cooperation is working together to accomplish shared goals. In cooperative learning situations there is a positive interdependence among students' goal attainments: Students perceive that they can reach their learning goals if and only if the other students in the learning group also reach their goals.

In the late 1700s Joseph Lancaster and Andrew bell made extensive use of cooperative learning groups in England, and the idea was brought to America when a Lancastrian school was open in New York City in 1806. Within the Common School Movement in the United States in the early 1800s there was a strong emphasis on cooperative learning.

Social psychological research on cooperation dates back to the 1920's (Slavin, 1977), but research on specific applications of cooperative to the classroom did not begin until the early 1970's. At that time, for independent groups of researcher began to develop and research cooperative learning method in classroom settings.

Johnson & Johnson generalize several characteristics that cooperative learning differs from traditional instruction of group: 1. Teachers abandon the model of lecture in the class. 2. Learner would become an actively participator at the learning process. 3. Learner and teachers are learning together and sharing the information of learning. 4. Not that we deliver the Knowledge, but that we create it. Ellis and Fouts (1997) believe cooperative learning is one of the more important educational innovations of our time. Table 1 is a comparison sheet of appropriate cooperation, appropriate competition, and appropriate individualization.

Table 1 Goal Structures

	APPROPRIATE COOPERATION	APPROPRIATE COMPETITION	APPROPRIATE INDIVIDUALIZATION
Interdependence	Positive	Negative	None
Type of Instructional	Any instructional task. The more conceptual and complex the task, the greater the cooperation.	Skill practice, knowledge recall and review, assignment is clear with rules for competing specified.	Simple skill or knowledge acquisitions; assignment is clear and behavior specified to avoid confusion and need for extra help.
Perception of Goal Importance	Goal is perceived to be important.	Goal is not perceived to be of large importance to the students, and they can accept either winning or losing.	Goal is perceived as important for each student; students see tasks as worthwhile and relevant, and each student expects eventually to achieve his or her goal.
Teacher-Student Interaction	Teacher monitors and intervenes in learning groups to teach collaborative skills.	Teacher is perceived to be the major source of assistance, feedback, reinforcement, and support. Teacher is available for questions and clarification of the rules; teacher referees disputes and judges correctness of answers, rewards the winners.	Teacher is perceived to be the major source of assistance, feedback, reinforcement, and support.
Student-Materials Interaction	Materials are arranged according to purpose of lesson.	Set of materials for each triad or for each student.	Complete set of materials and instructions for each student. Rules, procedures, answers are clear. Adequate space for each student.
Student-Student Interaction	Prolonged and intense interaction among students, heaping and sharing, oral rehearsal of material being studied, peer tutoring, and general support and encouragement.	Observing other students in one's triad. Some talking among students. Students grouped in homogeneous triads to ensure equal chance of winning.	None; students work on their own with little or no interaction with classmates.
Room Arrangement	Small groups.	Students placed in triads or small clusters.	Separate desks or carrels with as can be provided.
Evaluation Procedures	Criterion-referenced.	Norm-referenced.	Criterion-referenced.

Source Johnson & Johnson, 1994, Learning Together and Alone, p.p. 6-7

# Methodology

## *Action Research*

The action research contribution began in the 1940s' with studies conducted by social scientists John Collier, Kurt Lewin, and William Whyte. They discovered that research needed to be closely linked to action if organization member were to use it to manage change. A collaborative effort was initiated between organization member and social scientists to collect research data about an organizations' functioning, to analyze it for causes of problems, and to devise and implement solutions (Cummings & Worley, 2001).

Action Research combines action with research. Action research has applied to curricular innovation, school education innovation, and the growth of teachers' specialty. Action research not only can solve the practical problem of education, but also can reap no little benefit through research. In general speaking, action research can suitable for educational administration, school administration, and curricular research and development, and pedagogy, and learning strategy, and students' attitude and value, and education expert, and classroom management, etc. The Figure 1 is an action research cycle.

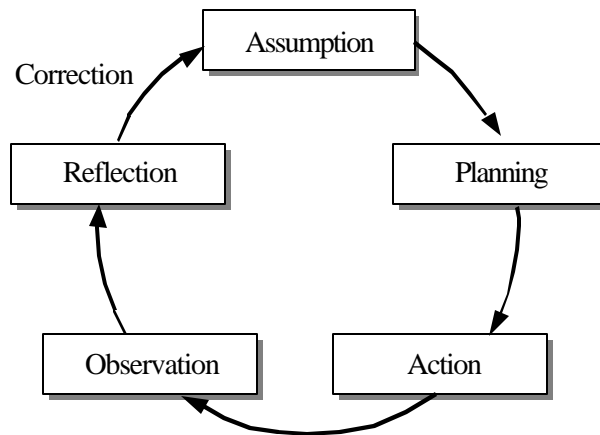


Figure 1 Action research Cycle

Action Research methodology provides the interplay between 'theory' and 'practice'.

1. Data Collection:

This research collected data by various: research diaries, observation materials, and students' self-estimation, and students' study records in Cyber University, and homework, and teaching estimation etc.

- a. Research diaries: We wrote the research diaries after teaching in each week. It was recorded about the teaching circumstance, interaction circumstance, and the problem what we find. It can help us reflect the teaching.
- b. Observations: We arrange an assistant to observe in this class. Assistant must observe about attitude, learning circumstance, and learning response. And keep records of observation.
- c. Students' self-estimation: After the ending of very bigger unit, we will have students make a self-estimation to weigh his learning condition and share every students' experience in the course.
- d. Students' study records in Cyber University: Using our Cyber University system, we can know well students' learning status that includes studying period, studying items, and the ranking of studying.
- e. Homework: We assigned the weekly homework after every course. The homework was post on the web of Cyber University. Cyber University system would record the data about students' name, homework, and submitting time.
- f. Teaching estimation: Students had to fill up the questionnaire in the end-of-term.

## 2. Data Analysis

- a. Data reading
- b. Data selecting
- c. Data explaining and make a conclusion

## Process

The research process of this paper includes clarifying research questions, establishing framework of action research, and proceeding action, and collecting data, and analyzing data, and writing paper. The process is shown in Figure 2:

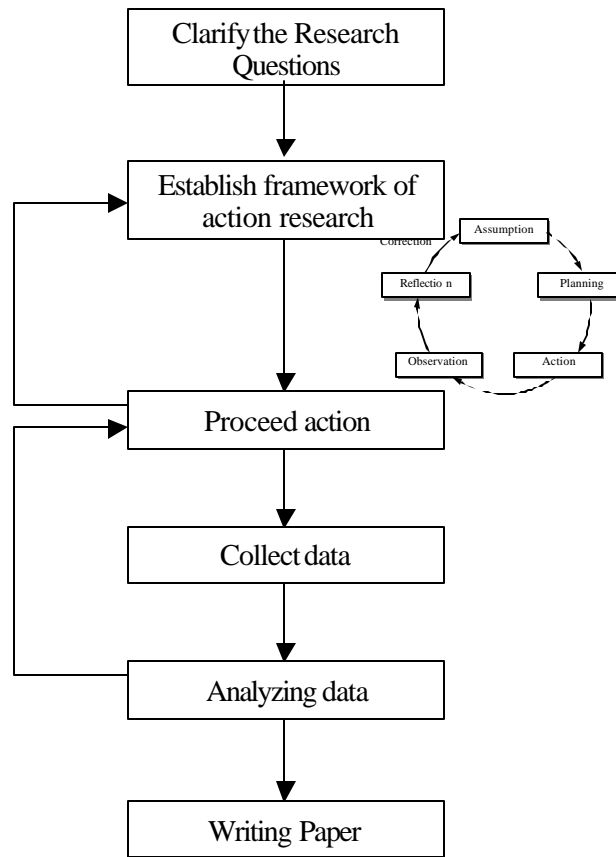


Figure 2 Research Process

1. Clarify the Research Questions:

We believe that instructional design is more important than proceeding. Our concern is to consider arising the learning motivation through cooperative learning and establishing the principles of teaching.

2. Establish framework of action research:

This framework of paper estimated a research basis on action research. Action research includes assumptions, action plan, and action executions, and observations, and reflections, and collection, and assumptions of modification. There were several small action research once week.

(1) Assumption:

Assumptions are guidelines that can direct us to do the research. This paper includes three elements: teaching, learning, and practice. Teaching what is called

means the teachers what to teach and how to teach. Learning what is called means students what to learn and how to learn. Practice what is called means that teachers and students how to get in this process. We had three assumptions as follow:

- a. Classroom setting could influence interactions.
- b. Learning step-by-step would raise the learning motivation.
- c. Relation of interaction could influence their wish of participation.

(2) Plan:

Plan includes process and content. Process plans like learning process, learning design. Content plans like curriculum plan, curriculum content and so on.

(3) Action:

Action means the actions' implementation. It includes the really teaching, homework design and so on.

(4) Data Collection:

We had to collect relative data after actions and would use the triangulation to help us to verify them. Triangulation what is called means to use one and upward data at the same thing. We would do the cross-test through various data, methods, and persons.

*Actions and instructional designs:*

When we estimated the research process, we began to conceive the action research and instructional design. The major content is star with the research's assumptions. Instructional design and implementations are next. Observations and Reflections are last. Description as follows:

*Instructional designs and implementations:*

Cooperative learning is different from general learning in the arrangement of classroom. As Figure 3 A indicates, this is a general arrangement of classroom. Figure 3 B shows our design, which adopt cooperative learning. Tables are arranged around the classroom and office chairs are placed in a circle. We could change the arrangement with our needs. We also take three kinds of models: lecture, group discussion, and group sharing. The descriptions are as follows:

- a. Lecture: As Figure 3 C indicates, when we needed a lecture for teaching, we invited students would move onward instantly. Thus, they could learn with acquaintance according to their wish.

*Now, we have to explain this part. Everybody move onward please and your hands must touch this table or the front student's chair.*



- b. Group discussion: As Figure 3 D indicates, when we needed everybody discuss with groups, we would group students into 4-8 teams. There were 3 to 8 students with each team. And each team used talking stone to help discussions. Finally, each team had to elect one person for representing their results.

*Please gather in 4-numbers team and discuss this subject. Before sharing, we have to elect a person who will represent your conclusions.*

- c. Group sharing: As Figure 3 B indicates, Students gathered in a big circle while we wanted that they could share their opinions. We shared what they had learned, what they had met, and provided experience about learning.

*When you hold the talking stone you must say something about your opinions, and the others please concentrate on listening.*

#### *Observations:*

According to the assumptions, action plans, and action results, we observed the process of learning, their interactions, and group discussions.

#### *Reflections:*

We reflected according to the data of observation and found out the gap between prospect and reality. The purpose of reflection is to inspect our designs of instruction. We would adjust the assumptions or designs as well as finding the gaps. For instance, when we found a group, which was not discussing very well, we exchanged with others immediately.

#### *Participative learning:*

Participation is very important for our design. We believe a proverb: Teach me I will forget; show me I will remember; involve me I will understand. We assume that students would not feel boring when they participate in discussions. And they would concentrate and make more effort.

#### *Immediate feedback:*

The purpose of instruction is to provide the guidance of learning progressively. Immediate feedback could overcome the learning barrier. For example, students usually encountered two situations when they build up the system dynamics model: the first situation, it is different between watching other people manipulating the

computer and manipulating computer by yourself. The second situation, if you don't manipulate the computer completely. If we remind some skill of modeling immediately, it will yield twice the result with half the effort. If we do not give some feedback, it will get half the result with twice the effort.

*Finding the gaps:*

Cooperative learning can help us to find out the gap each other. Generally speaking, people begin aware and learn while they find other people are more superior. Finding the gap is a balance feedback loop. To the class, cooperative learning would be a virtuous circle. Students can modify their learning action through understanding the gap between other students and themselves.

*Please gather in a big circle. Take your homework and pass to the left. Now you will get the other homework. Please read it particularity. If you complete your reading, please pass to the left unilaterally.*

*Homework:*

We would assign the homework to person or group after the course. We hoped that the weekly homework not only could help students practice, but also learning. The content of homework related with weekly progress. The degree of difficulty of homework depended on students' learning capacity. We did our best to create the learning tensions. Learning tension come from learning gap. We assumed if they found the learning gaps, they would modify their learning.

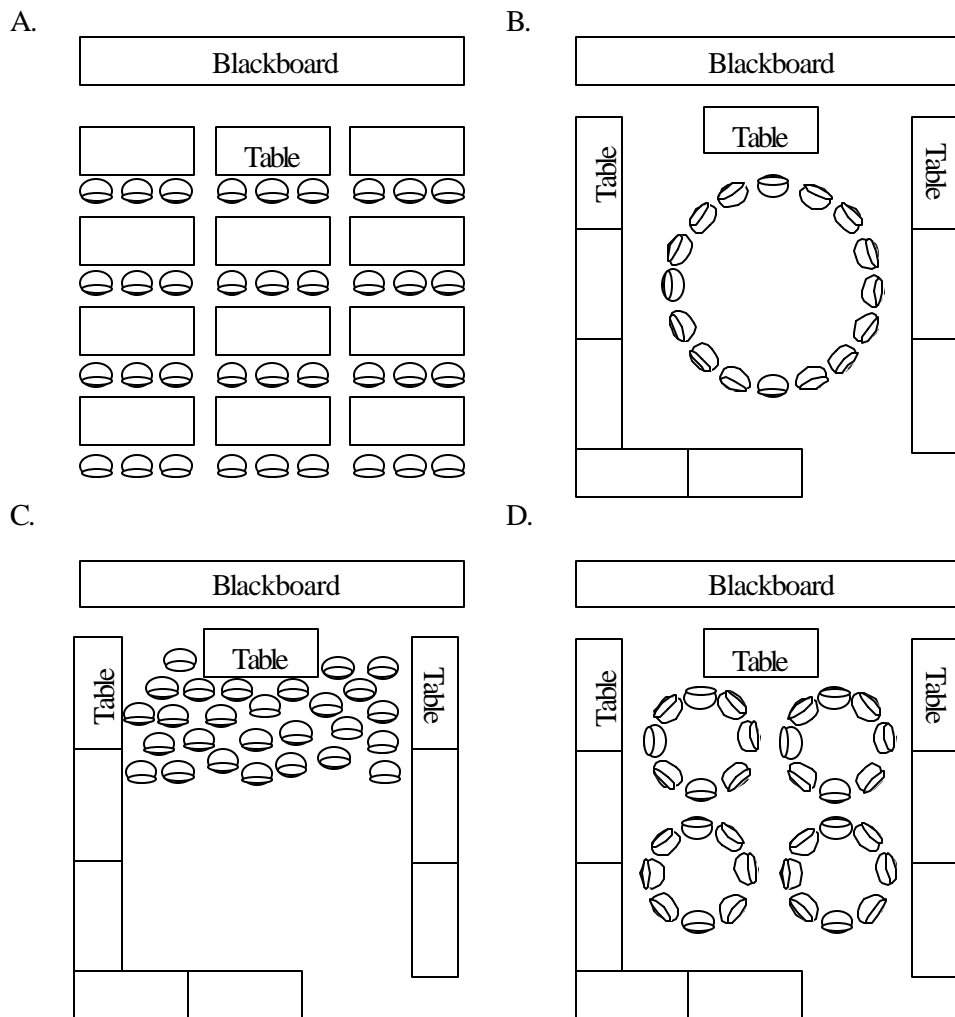


Figure 3 The Design of Classroom

## Discussion

When cooperative learning began to practice, most of students in Taiwan were used to listening to teachers' lecture over a long period of time. Students usually conform to teachers' request at the assessment. Owing to the new way, some student were not used to it. However, students could accept gradually when we intervened some technique of organizational learning, which liked talking stone.

In the past experience, we found that students usually had two polarizes of result in system dynamics if they could accept it, they would be fond of it, on the contrary, if they couldn't, they would learn it perfunctorily. For this reason, we interchanged

system dynamics with systems thinking and we could arise students' interest. The Figure 4 indicates that as the degree of acceptance grow, effort grows, and result grows, and interest grows.

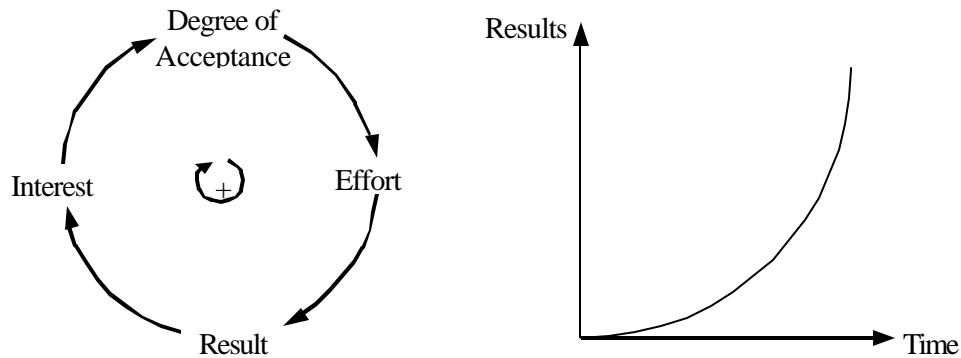


Figure 4 Reinforce of Interest and Effort

This paper hoped to build the cooperative learning model through action research on the instruction of system dynamics. The class and the number of people on cooperative learning usually is not so much. To discuss more conveniently, we have to create an environment, which is suitably. The Classroom that we select is that tables are on the side of the walls and the chair is circled in the center. Students can move and discuss more freely. When we wanted to lecture on the course, we could request them to move onward. The purpose was that we wanted students could be more concentration and interacted better.

We gathered in circle and took the “talking stone” in turn in order to create a good interaction on the discussion and students could discuss sufficiently. Since our early ancestors gathered in circles around the warmth of a fire, conversation has been a primary process for making sense of our world, discovering what we value, sharing knowledge, and imagining our future. (Brown, 2001) Students had interest in express their self as soon as they participated in it.

Because of the scope of system dynamics is quite broad, thus, we need to set up the goal of instruction and can't just lose the focus. The goal what we set up to be our main axis of teaching this semester is reflection. The meaning of reflection is that student can acquire the knowledge and put theories to the proof in the life. Besides, on the design of the content of instruction, we want to lower threshold with systems thinking, to arise interesting with management flight simulator, to assist understanding about systems thinking with modeling.

As the diagram Table 2 indicates, this table is a factor, we extract 3 factors and give a name to instructional Design, auxiliary teaching materials, and cooperative learning.

Table 2 The Result of Element Analysis of Instructional Estimation

	Questions	compon ent	Cronbach's	Eigenval ues	% of Variance	Cumulativ e %
Instructional Design	E3 I feel discussing at cyber university could help us accomplish our homework.	0.710				
	F4 I feel that I would have gains while we finish the class.	0.698				
	G1 Generally, I feel that the course of systems thinking is very practical.	0.689				
	G3 When I finish this course, I will introduce it to other students.	0.658	84.49	6.246	24.982	24.982
	F1 I feel that I could further understanding from beer game.	0.622				
	C1 I felt very novelty that we didn't use tables in this classroom.	0.610				
	D3 I feel that I could further understanding about modeling through systems archetypes.	0.596				
	E4 I feel that I could reduce the time of self-gropes, while I interact with teacher immediately.	0.558				
	C2 I feel that I could sense comfortable, while I could move the chair at will.	0.523				
	D1 I feel that I could improve the learning result, while I wrote the archetypes by memory.	0.504				
Auxiliary teaching materials	F3 I feel that I could reflect the managerial educations, while I had understood PE more.	0.731				
	F2 I feel that I could understand systems thinking further, while I had played PE.	0.695	74.45	3.066	12.265	37.248
	D5 I feel that weekly homework could help us to learn systems archetype or modeling well.	0.581				
Cooperative Learning	E1 I feel that group discussions could contribute to our learning in the class.	0.624				
	E2 I feel that I could sense interesting, while we had group discussions with classmates in the class.	0.620	69.99	2.059	8.236	54.538
	D7 I can feel that this course was to proceed step-by-step.	0.606				

## Conclusions

To be a teacher, it is our unshirkable responsibility to do education well. Action research can let us know that design is more important than teaching. We tried to design proceeding the instruction through cooperative learning in this term. In our belief, reducing teachers' intervention could acquire students' effort. Cooperative learning changed our viewpoint of teaching, moreover, it also changed students' viewpoint of learning.

We acquired five conclusions with the impact of action research which intervened the activities of teaching by questionnaires in this paper: (1) the scope of system dynamics is quite broad, thus, teaching needs to be adjusted in accordance with various conditions. (2) cooperative learning can enhance learning results and learning enforcing. (3) action research will be a good guidance for teaching system dynamics through cooperative learning. (4) systems thinking and system dynamics are complementary. (5) instructional design must have systematic characteristics and be implemented step-by-step.

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