**Evaluating Effects of A Systems Thinking Model
on Curriculum and Instruction Reform in Taiwan**

Chao-Li Hsu, Hsiao-Shen Wang & Yuen-Ju Chen

National Taichung Teachers College, Taiwan
Department of Elementary Education
140 Ming-Shen Road
Taichung, Taiwan 403
Tel: 04-2229-0852
E-mail: chaoli@mail.ntctc.edu.tw

Abstract. Given that systems thinking is a useful methodology in organization learning, the main purpose of this study was to identify and evaluate how and in what ways we could use systems thinking on curriculum/instruction planning in schools.

In this study, we used ethnographic methods of observation and in-depth interviewing to gather information. The study took place in six public elementary schools. The evaluation was focused on the following questions: (a) What happened when systems thinking model were used in the planning of curriculum/instruction?, (b) What did principals, academic administrator, and teachers think about using systems thinking model in the planning of curriculum/instruction? (c) What did teachers think about using systems thinking during instruction? and (d) In what ways did the use of systems thinking model influenced teacher professional development and satisfaction? Evaluation data was collected from five primary sources: (a) principals' and administrators' interview on the teachers' level of engagement in curriculum planning and interactions, (b) teachers' curriculum and lesson plans; (c) teachers' interview on the use of systems thinking model and their attitude toward the use of systems thinking model; (d) teachers' responses to an attitude survey; and (e) researchers' observational notes during implementation of the project.

Conclusions made based on the results of this study. First, systems thinking can increase the quality of administrator-teacher and teacher-teacher interaction, teachers' curriculum/instruction planning, continuous assessment of curriculum/instruction, and immediate and formative feedback. Secondly, it can also decrease overall time required on task of curriculum/instruction designing in the long run. Consequently, it promises curriculum/instruction design with more accountable quality.

Key words: organization learning, systems thinking, professional development, elementary schools, curriculum development

INTRODUCTION

Reports show that systems thinking has always been valued in many disciplines like biology (Myers-Bowman, 1998; Wolf, 1994), information technology(Lumb, 2004; McDavid, 1996; Tasgal, 2003), economics(Oldridge, 2003; Tasgal, 2003; *Reichelt, & Lyneis, 1998*), medicine(Aspy, 2001; Sorrells-Jones, 1999; *Tarek Abdel-Hamid, 2002*), engineering(*Rodrigues & Bowers, 1996; Wickens1, 1992*), and psychology(Beels, 2002; Davidson, 2000), to name a few. As Senge(1993) stated, systems thinking is "a way of thinking about, and a language for describing and understanding, the forces and interrelationships that shape the behavior of systems". One of the primary advantages of systems thinking for educators, when implementing openly, is that it fits well with team work and continuous improvement. A person with an understanding of systems sees the elements in common in diverse settings rather than focusing solely on differences. Furthermore, it can encourage creative thinking and generate new ways of doing things (Forrester, 1994).

While systems thinking has pervaded in the field of modern management such as TQM(Overholt, 2004; Reichelt, 1998) and education(Checkland, 1993; Altamirano & van Daalen, 2004; Biber & Kasperidus, 2004; DiFrancesca & Dale, 2004) around the world, it's still hard to quantify the number of public schools using systems thinking and the way it has been used to improve educators' competency, simply because the methodology has never really been a need to schools due to the central curriculum policy before the 1996 textbook reform and 2001 steps further curriculum reform launched in Taiwan.

Eventually, the National Taichung Teachers College received a grant from the Ministry of Education in Summer, 2003. Part of the project's purposes was to explore the possibility of implementing systems thinking to improve elementary principals' curriculum leadership urgently needed in the 2001 Nine-Year Integration Curriculum Reform almost 20 years after the concepts of systems thinking were first introduced to the education community in Taiwan (Kemp, 1985; Associations for Education Communications and Technology, 1988; Hsu, 1989). To accomplish the proposed project's goals, the Department of Continuing Education initiated a workshop in which a systems thinking model (Figure 1) and main concepts such as information era, knowledge
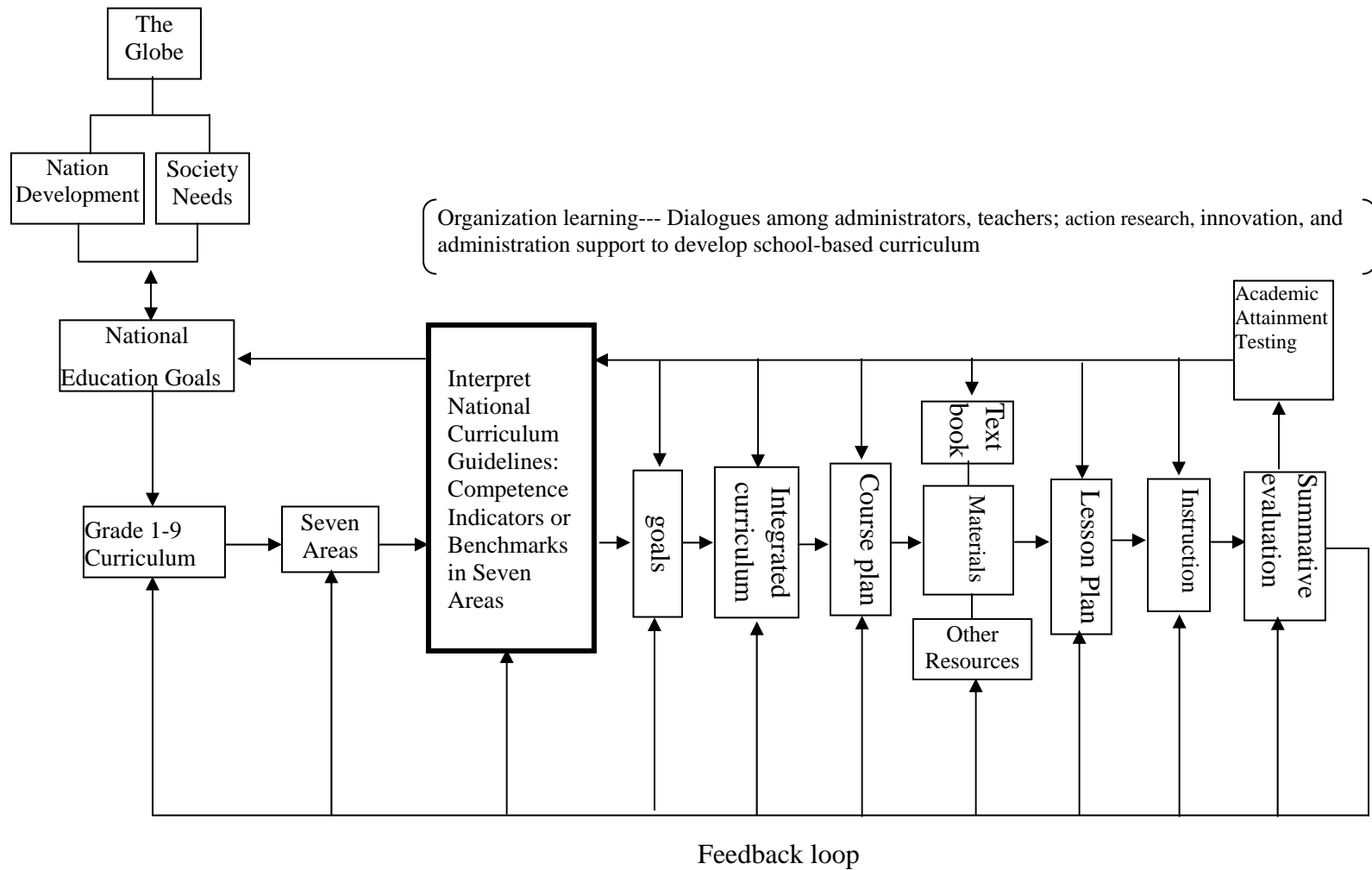
The Globe

Nation Development

Society Needs

Organization learning--- Dialogues among administrators, teachers; action research, innovation, and administration support to develop school-based curriculum

Academic Attainment Testing

National Education Goals

Interpret National Curriculum Guidelines: Competence Indicators or Benchmarks in Seven Areas

Grade 1-9 Curriculum

Seven Areas

goals

Integrated curriculum

Course plan

Text book

Materials

Other Resources

Lesson Plan

Instruction

Summative evaluation

Feedback loop

Figure 1 System thinking model for 1-9 curriculum/instruction(Hsu   2002)

era, edge of chaos, fluidity, constant change, knowledge networks, knowledge communities, complexly interactive processes, global economy, knowledge-creating dialogue, co-creating value, non-linear, teaming/collaboration, innovation, tough challenges and education for next generation, and especially interconnectedness, were introduced 3 hours of the totally 12 hours lectures. Afterwards, some schools have begun to explore how systems thinking could be used to facilitate organization learning and improve teachers' curriculum/instruction planning competency following the principals' positive experiences from learning the systems thinking concepts.

Gradually, in K-12 education across Taiwan, schools has started to set foot in using systems thinking and primarily implemented it as a supplementary, like extracurricular learning activities. Other than schools, the His-Fu Cultural Foundation which is a part of the Megatop group of Taiwan has introduced "The Fifth Disciplines" to its society and built a learning infrastructure by developing reading forum for managers. In education, they have organized systems thinking camps for grades 3-6 since 1995 (Tu, 1998). Still, there has not been much systematic research to investigate the effects of systems thinking on school management; nor has there been much research evidencing that systems thinking can improve the quality of teachers' engagement in curriculum/instruction development. As a result, schools that have adopted systems thinking to date have done so without the benefit of research to guide them. Consequently, the fact that there is not much evidence to indicate how the use of this methodology affects school accountability has deterred schools and teachers from integrating them into their professional development.

Given that the system thinking is a useful methodology in organization learning (Senge, 1993; Forrester, 1997), the question was not to investigate whether or not the use of systems thinking is effective in aiding teachers' professional development. Rather, a more important challenge was to identify how and in what ways we could use systems thinking in schools. The purpose of this paper is to use the literature on methodology of systems thinking to develop a model for curriculum-integration and instruction design for administrators and teachers in elementary schools. It specifically explains how such a model was developed and further implemented and what the evaluation results are. The paper also provides some insights on what was learned from this study.

METHODS

Design and Subjects

We employed a descriptive, naturalistic evaluation design in which a curriculum/instruction systems thinking model was implemented as the guidelines of the schools' curriculum/instruction planning. Using ethnographic methods of observation and in-depth interviewing to gather information and to address the complexities of systems thinking implementation in schools, the study took place in six public elementary schools located in one county next to a central metropolitan area, Taichung, of nearly one million people. All of the schools were situated in various suburban areas, enrolling 140(school A), 374(school B), 1040(school C), 1109(school D), 1678(school E), and 2256(school F) students; and employing 16, 28, 56, 58, 89, 116 teachers respectively in 2004 academic year. Class sizes in the schools ranged from 30 to 35 students. Although, based on the Curriculum Regulation issued by the Ministry of Education (Ministry of Education, 2003), the school-based curriculum and instruction should be managed by a Curriculum Development Committee. In the real world, however, they were loosely functioning due to the lack of experiences/competency in curriculum development although these committees were well-structured in documents presented almost in all schools (Bureau of Education, 2004).

During the initial stage of designing this study, the researchers realized that it was a need to design and develop a systems thinking model specifically for the elementary schools struggling in complex circumstance under massive curriculum reform. In the following sections we will first discuss how we used the existing literature on systems dynamics and systems thinking to develop the model. We will then explain how we implemented and evaluated this model in school setting and present the results.

Before implementation, the key of model designing can be categorized into two steps as follows: developing a dynamic hypothesis explaining the cause of the problem, and building a systems thinking model for curriculum/instruction planning at the root of the problem.

Developing a dynamic hypothesis explaining the cause of the problem

Using the method of identifying a problem as the first strategy of constructing the model, we first identified that the 2001 curriculum reform is not only massive but also serious which included the aspects of textbook open market reform, paradigm shift, national curriculum

guidelines revision, and school autonomy. In addition, the "year hopping plan" (Table 1) of reform make the so-called "nine-year integrated curriculum" neither lateral nor vertical integrated in the real world.

Table1 Year hopping plan policy of the Nine-Year Integrated Curriculum Reform

School year	1st	2nd	3rd	4th	5th	6th	7th	8th	9th
2001-2002	˘								
2002-2003	˘	˘		˘			˘		
2003-2004	˘	˘	˘	˘	˘		˘	˘	
2004-	˘	˘	˘	˘	˘	˘	˘	˘	˘

First of all, the key concept in nine-year integrated curriculum is "integrated", but in fact there are many cases of redundant or conflicting elements in the national curriculum guidelines itself. Secondly, elementary education curriculum standards had always been extremely detailed under the central policy in the past. As a result, there has been little to choose other than the textbooks compiled by the National Institute for Compilation and Translation and the task of choosing a textbook as "Bible" never involved much controversy (Figure 2). The boxes in grey meant that teachers were not involved in those tasks.

National Standards → Textbooks Compiled by NICT → Instruction Following Textbooks → Summative Evaluation
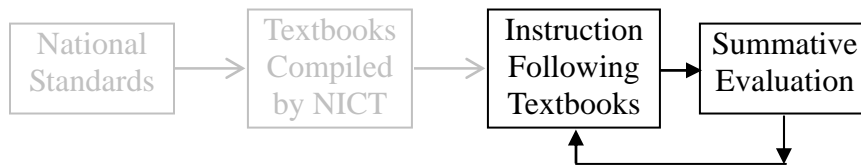
Figure 2 Curriculum/instruction loop before 2001 curriculum reform

However, the new curriculum provides only general guidelines. Publishers who are joining the newly open textbook market compiling textbooks under these guidelines will naturally differ in content. According to a recent civic survey (China Times, 2005/3/7), the massive reform makes significant people like teachers, parents, and students uncertain and nervous that standardized tests of high school entrance examination might require knowledge of something not covered by a given publisher's textbook. Finally, encouraging diversity in instruction and

learning is another key aspect of the concept of the school-based curriculum. Based on the regulation of "school autonomy", the so-called "school-based curriculum" means 20% of the curriculum has left for schools and teachers to create.

Since textbooks have long held the status of like a classroom Bible, it seems that textbooks play very important role in translating the national curriculum guidelines into a classroom reality and schools keep expecting so. Unfortunately, the diverse and hopping reform reality force textbooks no longer provide teachers the easiness they have always had leaned on in the past. With all the problems come to a head, who is supposed to iron out the problems? How to achieve lateral and vertical integration between the content of different textbooks as quickly as possible if textbooks still play a key role in instruction? While the innovative/creative teaching plays an indispensable role in the information era, it looks like that schools as a whole have to organize their curriculum and teachers have to make adjustments accordingly to involve in curriculum development and to further prepare themselves for the new professional era.

Since literature has shown that Education is an important area of application for system thinking, with organization learning, it will guide teacher as learner to become actively involved. Unlike scientists who study the world by breaking it up into smaller pieces, system dynamics researchers/thinkers look at things as a whole. The objects and people in a system interact through feedback loops, where a change in one variable affects other variables over time, which in turn affects the original variable, and so on. Therefore, the application of system thinking makes it an excellent tool for integrating diverse elements into a whole which is the key task in current curriculum reform.

Building a systems thinking model of Curriculum/Instruction planning at the root of the problem

Although the literature on curriculum/instruction planning does not identify a universal practice, we can find a number of key principles of instruction design underlying best practices (e.g., Bransford, Brown, & Cocking, 1999, 2000; Merrill, 2002, etc.). These principles are found in contemporary instructional design theories and models and are being practiced by instructional designers and teachers in their design and delivery of instruction (Dick and Carey, 2004; Huang, 2004). These principles can be summarized as "identify goals, conduct analysis, identify entry behavior, develop instructional strategies, develop instructional materials, design lesson plans,

formative/summative evaluation, feedback & revision."

Based on the above instruction design principles and more systems thinking principles incorporated, the model in Figure 1 was simplified to a curriculum/instruction feedback loop (Figure 3a) instead of "textbooks as Bible" (Figure 2) for easier use under the consideration of the participants' entry behavior. The model was used to design, develop and evaluate integrated curriculum from first to sixth grade in the participant schools. In this study, an integrated curriculum meant the completion of course nature analysis, first to sixth grade vertical consecutive goals, related materials, and a minimum of two, 45-minute sample lesson plans for at least one subject.

Data Collection

Evaluation data was collected from four primary sources: (a) principals' and administrators' interview on the teachers' level of engagement in curriculum planning and interactions, (b) teachers' curriculum and lesson plans; (c) teachers' interview on the use of systems thinking model and their attitude toward the use of systems thinking model for different subjects; (d) teachers' responses to an attitude survey which measured teachers' general attitude toward the use of systems thinking model and their attitude toward the use of systems thinking model for different subjects; and (e) researchers' observational notes during implementation of the project. A combination of quantitative and qualitative analysis was used to make sense of the evaluation data.

Procedure

Since the main purpose of the study was to assess the school implementation as it might be used by other schools interested in using systems thinking to plan curriculum/instruction, evaluation procedures evolved according to specific school circumstance, administrators and teachers interest and practical considerations. The evaluation was focused on the following questions: (a) What happened when systems thinking model were used in planning curriculum /instruction?, (b) What did principals, academic administrator, and teachers think about using systems thinking model in planning curriculum/instruction? (c) What did teachers think about using systems thinking during instruction? and (d) In what ways did the use of systems thinking model influenced teacher professional development and satisfaction? Four stages of

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implementation described as follows:

Stage One: Principals' understanding and support curriculum reform

The first stage assessed willingness of schools to implement systems thinking model. Before initial entrance into the schools, the researchers met with the Chief of the County Bureau of Education and principals and briefly explained the project and study methods. The Chief agreed to support the project and all the school principals seemed to welcome the one-year study efforts, apparently from the positive learning experiences in the workshop coordinated for the principals before the study as they stated.

Stage Two: Academic Administrators' Workshops---To understand the model and to know how to implement at school

At stage two, the County Bureau of Education initiated a workshop for academic administrators (As) which was three hours a week, and lasted for seven weeks in Winter, 2003 . Other 40 As who were not participants of this study also attended. The purpose of the workshop was to train the As to understand what was the systems thinking model and to know how to implement and localize it at school (Figure 4). In this study, the systems thinking model consisted of C& I "WHAT & HOW" loop (Figure 3a), researcher as engine reinforcing loop (Figure 4a), A1~A6 practiced to be engines of grade team reinforcing loop (Figure 4b), and researcher as coordinator of 1st~6th grade goal integration reinforcing loop (Figure 4c).

In preparation to extend the implementation of systems thinking, the researcher developed key guidelines for participants' references as follow:

A. Preparing the workshop

- Preparing hardware: Set the environment and one notebook or PC for each of the 1st ~6th grade teams to record the content of curriculum and instruction planned
- Preparing materials: Printouts of Competence Indicators; examples of curriculum & lesson plan; handouts of step by step guidelines; list of materials, handouts and forms available on web pages (www.ntctc.edu.tw/chaoli)

B. Outlines of the model covered in lecture and demonstration

Overall, the purpose of lecture and demonstration was to increase participants' background knowledge on the philosophy, theoretical bases, content and implementation procedure of the

systems thinking model. The guidelines were as follow:

- The introduction of the systems thinking model
- The course nature of each of the seven areas: Math, Language, Science, Social Studies, Arts, Health and Physical Education, and Comprehensive Activities
- Identifying the KEY ELEMENTS of each of the National Competence Indicators and its lateral/vertical integration to construct the $1^{st} \sim 6^{th}$ grade goal map (Hayes & Ahrens, 1988)
- The meaning and benefits of student-centered learning
- Textbooks are not Bible anymore.
- The method of choosing textbooks and developing school-based materials.
- Instructional strategy and learning pyramid
- The interaction between elements
- Students and colleagues as mentors: Incorporating feedback from colleagues and students in the planning and instruction process
- To demonstrate the details of implementing the model and to promote high levels of interactivity among administrators, the researcher first acted as an engine to facilitate collaboration learning and active participation (Figure 4a).
- Secondly, administrators trained were promoted to engines to replace the role of the researcher played. Administrators from the same school district worked as a team. Using the one of the curriculum plan tables (Appendix A), each team first identified key grade goals (Figure 4b). Administrators were expected to exchange dialogues based on the national curriculum guidelines, share knowledge with their own team members to identify key school-based grade goals.
- Finishing grade goals, $1^{st} \sim 6^{th}$ curriculum (goals) integration activity was conducted (Figure 4c). Administrators were expected to assess each other team's interpretations of the guidelines and check the vertical integration between goals of consecutive grades. Grade goals were revised if necessary.
- Based on the grade goal map, textbooks were evaluated and curriculum and instruction plans were preliminarily developed.
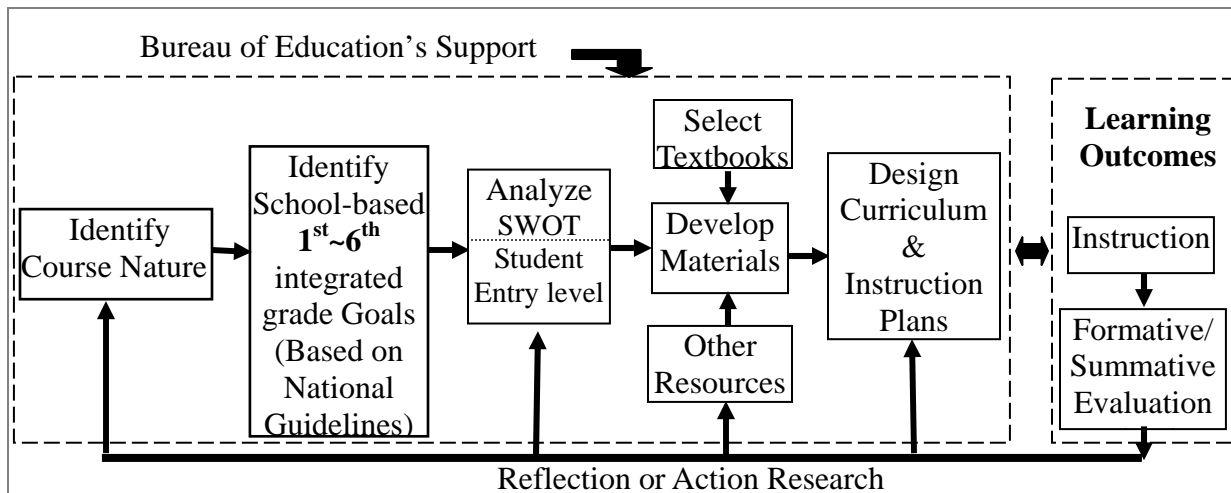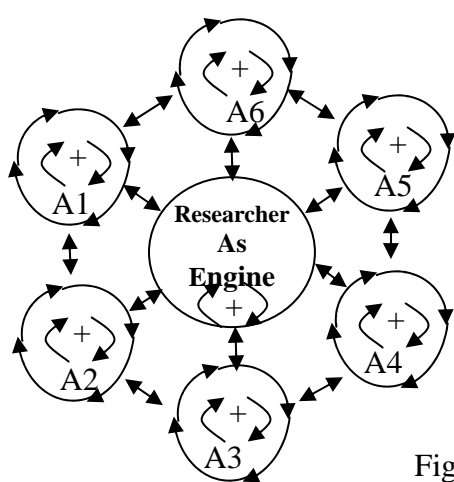
Bureau of Education's Support

Identify Course Nature

Identify School-based $1^{st}\sim6^{th}$ integrated grade Goals (Based on National Guidelines)

Analyze SWOT Student Entry level

Select Textbooks

Develop Materials

Other Resources

Design Curriculum & Instruction Plans

Learning Outcomes

Instruction

Formative/ Summative Evaluation

Reflection or Action Research

Figure 3a Curriculum & Instruction "HOW" loop

A6 A5 A1 A4 A2 A3

Researcher As Engine

Major task:
1. Using the loop above to identify grade goals
2. Integrate $1^{st}\sim6^{th}$ grade goals
3. Evaluating textbooks
4. Develop preliminary C & I plans

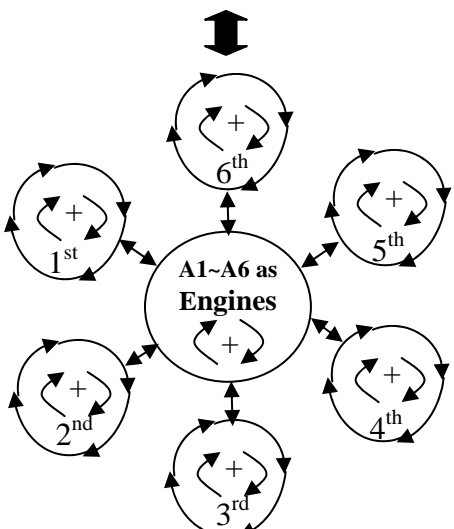Figure 4a Researcher as engine **seed reinforcing loop**

6th 5th 1st 4th 2nd 3rd

A1~A6 as Engines

A6+6th A5+5th A1+1st A4+4th A2+2nd A3+3rd

Researcher As Coordinator

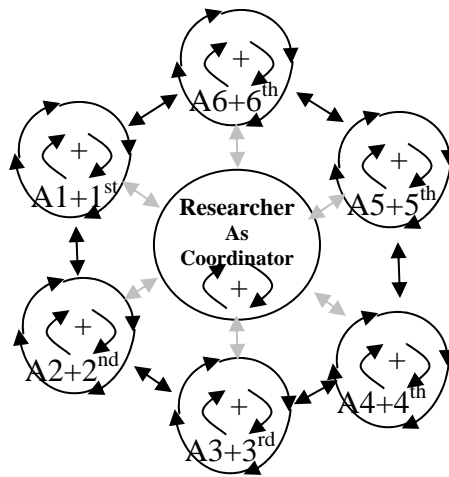Figure 4b A1~A6 practiced to be engines **grade team reinforcing loop**

Figure 4c Researcher as Coordinator $1^{st}\sim6^{th}$ **grade goal integration reinforcing loop**

Figure 4 Academic Administrators' Workshops ---
Implementing systems thinking model to develop C & I

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Regarding the research, the purposes were to use the results of this research to identify the best strategies for the use of systems thinking in elementary schools. Observer notes were used to collect impressions relevant to the model (e.g., ease of use, perceived effectiveness of the model). Curriculum and lesson plans were collected as well. After completing the workshop, the As were interviewed regarding his (her) experiences and reactions. Based on the data obtained, appropriate model revisions were made for further implementation back to schools.

Stage Three: School Curriculum & Instruction planning workshops

School curriculum & instruction planning workshops were initiated during the stage three. The purpose of the workshop was for administrators and teachers to internalize the systems thinking approach and curriculum & instruction planning competency by hands-on activity.

The academic administrator and the researcher collaborated on delivering the lectures and leading discussions similar to the procedure in stage 2 (Figure 5). Other than the guidelines implemented at Stage II, more specifications were integrated as followed:

A. Preparing the workshop

- Principal to do: Preliminary communication with teachers on the need of systems thinking before implementing it at school.
- Academic office to do: Designating the administrator and one teacher as the coordinate engine of each grade team (T1~T6) during group discussion

B. During the workshop

- The academic administrator played as a leading facilitator and the researcher consulting on site to help solving problems (Figure 3b). The number of each grade team depended on the size of the school. After constructing grade goal map (Figure 5a), the academic administrator leaded all teachers using large screen projection to check the vertical integration of all grade goals in a large group discussion (Figure 5b). Based on the integrated grade goals, each grade team evaluated textbooks, then completed the whole year curriculum plan (Appendixes B & C) followed by lesson plans (Appendix D) respectively by exchanging dialogues (Figure 5c).
- The researchers used the documents, observation of teacher engagement and records of problem in team dialogues to reflect on teacher understanding and effectiveness of the systems thinking model. Revised the implementation details whenever necessary.
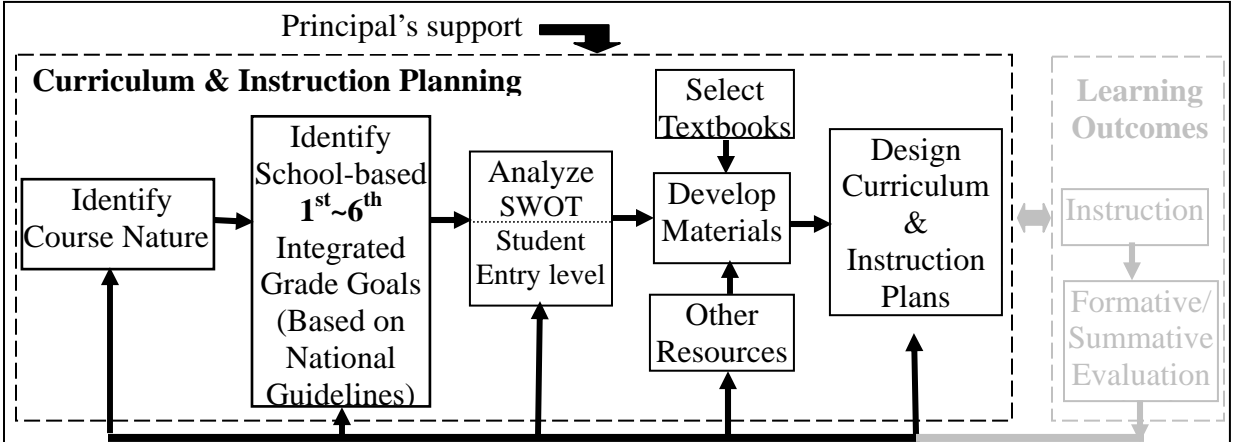
Principal's support

Curriculum & Instruction Planning

Identify Course Nature → Identify School-based $1^{st} \sim 6^{th}$ Integrated Grade Goals (Based on National Guidelines) → Analyze SWOT Student Entry level → Develop Materials → Design Curriculum & Instruction Plans

Select Textbooks

Other Resources

Learning Outcomes

Instruction

Formative/ Summative Evaluation

Reflection or Action Research

Figure 3b Curriculum & Instruction planning "HOW" & "WHAT" feedback loop

T6+6th T5+5th T1+1st T4+4th T2+2nd T3+3rd

A1 as Engine
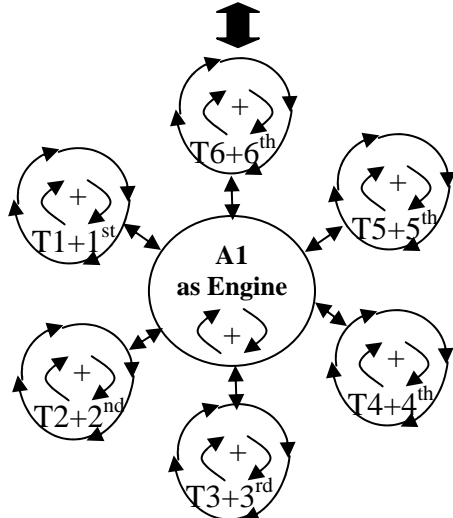
Figure 5a Grade goal reinforcing loop

T6+6th T1+1st T5+5th T2+2nd T4+4th T3+3rd

A1 as Coordinator
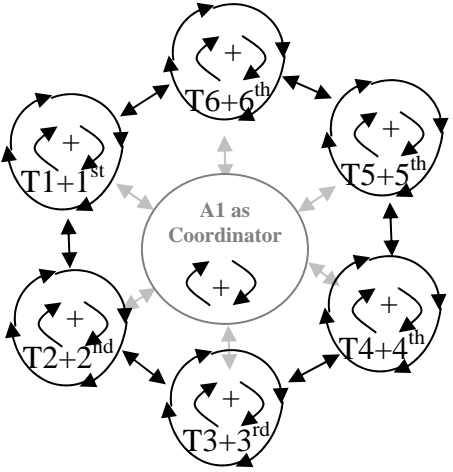
Figure 5b $1^{st} \sim 6^{th}$ grade goal integration reinforcing loop

$1^{st}6$ $1^{st}1$ $1^{st}5$ $1^{st}2$ $1^{st}4$ $1^{st}3$

T1 as Engine

Major task:
Based on the grade goals + SWOT + student level to:
1. Evaluate textbooks
2. Develop curriculum plans
3. Develop lesson plans
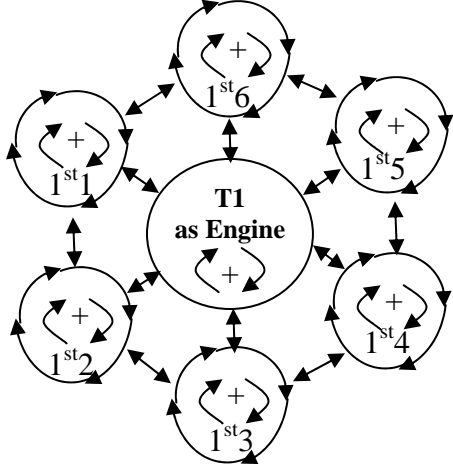
Figure 5c Textbooks evaluation & C/I plans developing loop

Figure 5 School Curriculum & Instruction planning workshops ---
Using systems thinking model

Stage Four   Instruction/learning and feedback

Instruction proceeded based on the curriculum/instruction plans the following semester. The following procedure summarizes the implementation strategies.

◆ The "1st~6th goals" (e.g. Appendix B) helped teachers monitor student learning (Figure 3c).

◆ At the beginning of the semester, teachers were asked to record feedback and problems encountered in the class sessions (Figure 3c, e.g. Appendix E). Academic administrators were asked to set intra network up for saving feedback records (e.g., Figure 7-1, 7-2 & 7-3) and followed by grade-mixed group discussions usually held once a week (Figure 6, e.g. Appendix F). For those large size schools which employing more than 15 teachers, teachers were proportionately grade-mixed into teams to discuss instruction problems and difficulties.

◆ Students' portfolios and sample works were regularly exhibited or interchanged (Figure 6).

Reflection or Action Research

Figure 3c Instruction & learning feedback loop (+-12 hrs)

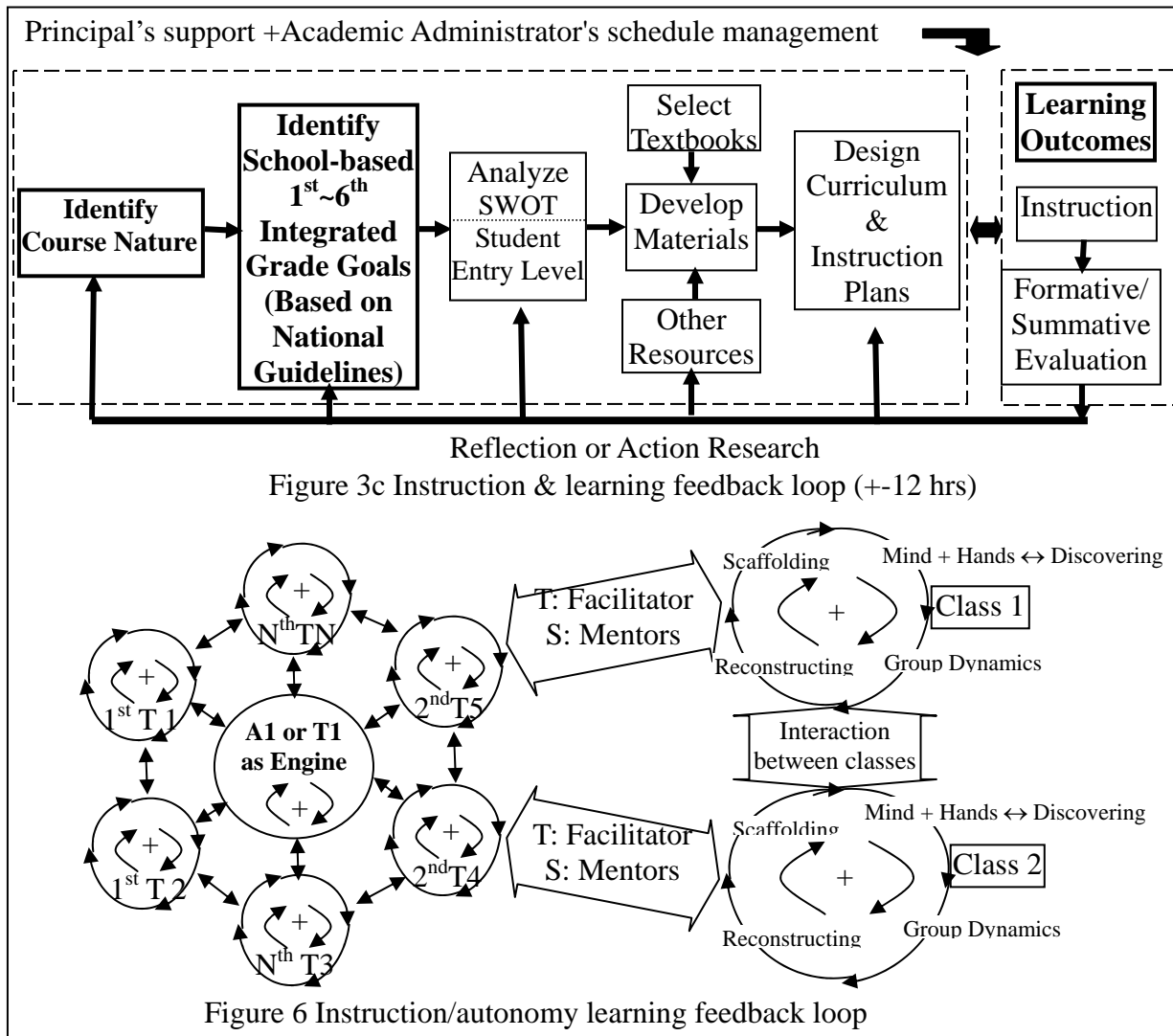Figure 6 Instruction/autonomy learning feedback loop

Figure 7-1 Part of School B's intra network including folders of curriculum plans, lesson plans, assessment tools, curriculum evaluation forms, reflection reports, et. al.

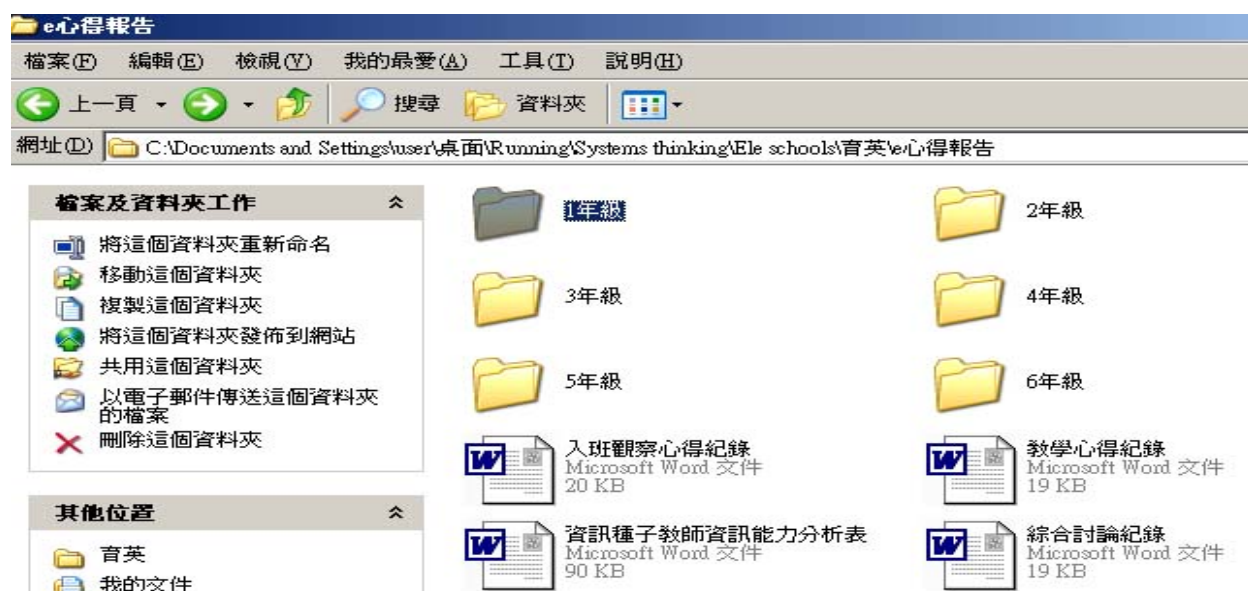Figure 7-2 School B's intra network---Sub-category of lesson-plans folder

Figure 7-3 School B's intra network--- Sub-category of reflection-reports folder

◆ The researcher reviewed schools' records and provided organization-based feedback to administrators, mostly through e-mails, partly through phone or on-site advices.

◆ A website was set up to provide basic materials and information or general feedback. The basic materials placed on the website were (www.ntctc.edu.tw/chaoli):

    - The map of systems thinking model

    - The philosophy and theory base of systems thinking

    - The introduction of systems thinking model: Powerpoint file

    - The guidelines of implementing systems thinking model

    - Materials of seven areas: Language Arts   Mandarin   English   Dialects   Mathematics   Science and Technology   Social Studies   Health and Physical Education   Arts and Humanities   Comprehensive Activities

    - Reports of action research

    - Curriculum and instruction evaluation forms

    - Handouts and references for implementing systems thinking model

◆ At the end of the try-out semester, teachers were interviewed and asked to complete a short anonymous attitude survey.

FINDINGS AND DISCUSSION

The findings are presented in four purposes of the study addressing: (a) What happened when systems thinking model were used in the planning of curriculum/instruction?, (b) What did principals, academic administrators, and teachers think about using systems thinking model in the planning of curriculum/instruction?, (c) What did teachers think about using systems thinking during instruction?, and (d) In what ways did the use of systems thinking model influenced teacher professional development and satisfaction?

What happened when systems thinking model were used in the planning of curriculum and instruction? Academic administrators' and researchers' reflection and observational/interview notes indicated that the use of systems thinking has gradually powered the school dynamics, consequently, improved the academic environment..

First of all, it has improved personnel interrelationship. Teachers worked as a whole instead of struggling individually. They were immersed during weekly workshops in contrast to grading papers while speakers lectured before. Academically, problems such as textbooks as "Bible",

paradigm shift, national curriculum guidelines revision, year hopping policy and school autonomy were no longer problems to these teachers. Teachers' attitude toward curriculum and instruction development has changed from primarily layback and confused to energetic and confident.

"Teachers' attitude toward implementing systems thinking model went through stages of grudging$\rightarrow$willing$\rightarrow$involved$\rightarrow$dedicated, and recently, immersed and can't stop", school B's and School F's Chief Academic Administrator stated. However, the timeline of transition from stage to stage was different across the six schools mainly depended by the executive style and pedagogy expertise of the "engine" especially in the beginning of the implementation. For example, after 35/36 years in elementary education field, the Chief Academic Administrators of school B and school F were enthusiastic, supportive and energetic with subject matter expertise. For these two schools, nine hours (three times) of group discussions working on the interpretation of National Curriculum Guidelines and examining textbooks seemed long enough to get all teachers prize systems thinking on curriculum and instruction. *"Hard work?"* Attendants of "Effects of Systems Thinking on Curriculum and Instruction Symposium" held by school B asked (May 31, 2005). *"Yes, but worth it."* T1 of School B replied and others consent in their comments. School B's Chief went further:

"After two years of using systems thinking, we have developed 1st~6th grade integrated C & I of Math, Language Arts, Science, Health and Physical Education, and Comprehensive Activities based on the National Guidelines and school-based culture and materials. The goal maps of these areas were crystal clear to our teachers because they have done the interpretation and integration as a whole themselves. All the materials and references they developed were on the intranet. Regarding instructional strategy, teachers provide scaffolding, facilitate autonomy learning by encouraging students to think and apply concepts learned into their real life. Teachers no longer deliver redundant lectures or conduct irrelevant activities only for activities to confuse students. In terms of plans, what we have kept doing on the prior versions (C & I) was micro-revision whenever necessary. That's why it decreased overall time/load on teachers and students. Just take a look at our teachers' confident and shining eyes and students' performance. What our teachers and students have developed within these two years is amazing." (Lee, May 31, 2005)

For other four participant schools, they took longer on stage transition of teacher attitude yet one semester was long enough to get most of the teachers to the dedicated or immersed point. As these Academic Administrators stated, using systems thinking model made them more responsive to teachers' and students' needs, helped teachers become more engaged during curriculum/instruction planning, and encouraged to participate more actively in planning discussions. In all six schools, the academic administrators felt at ease with the use of systems thinking model after the training workshops.

" I found that teachers become more active in group discussions. They started presenting their opinions and knowledge rather than just listening as they used to do before……".
(administrator A)

" ……Recently, I was so surprised at the giant improvement of students' abilities, the change even improved parents and kids relationship. Many parents told me that their children like the change very much. The kids shared things happened in classes again and again with their parents after school……." (administrator B)

" Our teachers have improved their professional ability. They develop their own instruction materials. They used to rely on textbooks as unchangeable guidelines before. Now, the situation has changed and, consequently, they understand their students more." (administrator C)

" We were surprised on the positive turnouts both on teachers' competency and students learning attitudes. I am working harder to arrange time for dialogues. Teachers chatted and learned professionally from each other. We have never had this kind of chat quality before. The result of learning dialogue has changed their ways of teaching, thinking and interaction." (administrator D)

"After our teachers experienced the benefits of systems thinking, they started to observe and manage things differently. One thing very important is that they need time to conduct dialogues. Sufficient time will make thorough and accurate thinking. As a result, they will always get to the points instead of doing things redundantly. This will definitely save a lot of time and work load……" (administrator E)

Moreover, the use of systems thinking model during planning improved both the quantity

and quality of teacher discussions. In addition, all six administrators were confident that their curriculum and instruction competency and leadership had gradually improved. Administrators believed that this result was due to the clear directions of knowledge sharing in organization learning, as well as the process of displaying each team's (grade's) interpretation and reflection to teachers of different grades for further discussion and elaboration. However, the new policy still created some dependency on the consultant of subject matter professionals. The administrators noted that although it temporarily took much planning time but the professional development would consequently decrease administrators', teachers' and students' confusion in the long run.

What did teachers think about using systems thinking model in the planning of curriculum and instruction? Analysis of responses to attitude survey's close-ended questions and interview notes showed that receiving immediate feedback through discussion influenced teacher curriculum design learning. Teachers also felt systems thinking model created more interaction, especially more interaction between the academic administrator and teachers and among teachers compare to between principal administrator/teachers. Systems thinking also enhanced their depth and width level of involvement during planning, and increased their motivation when developing curriculum (Table 2).

Table 2 Results of the attitude survey (N = 363)

Questions	Mean	Standard Deviation
1. The use of systems thinking created more interaction between principal and teachers.	3.90	0.53
2. The use of systems thinking created more interaction between academic administrator and teachers.	4.10	0.28
3. The use of systems thinking created more interaction among teachers.	4.63	0.28
4. The use of systems thinking helped me become involved during curriculum/instruction planning.	4.60	0.31
5. The use of systems thinking enhanced my involvement during group discussions.	4.53	0.34
6. The immediate feedback during group discussions made me evaluate my thought on curriculum/instruction more than I did before.	4.23	0.60
7. The use of systems thinking increased my motivation in organization learning.	4.07	0.50
8. The use of systems thinking made the curriculum/instruction more interesting.	4.10	.48

5 - Point scale with 5: Strongly agree, 4: Agree, 3: Undecided, 2 : Disagree, and 1: Strongly disagree

What did teachers think about using systems thinking during instruction? Teachers thought using systems thinking provided good learning experiences and helped them thoroughly understand and interpret the national curriculum guidelines. Consequently, the outcomes of using systems thinking was very successful and helpful on lowering cognitive load which were subsequently positive to facilitate student participation and learning. The following excerpts summarize some of the comments that teachers made.

"……For example, after interpreting the curriculum guidelines and thoroughly understand, I had the overall goals of life course crystal clear in mind and used them to facilitate kids to find out the phenomenon of "force", to record their findings, to analyze their findings, to induct their analysis, and finally, to edit their own report based on the findings. They did the learning, not I did it for them. I facilitated them to induct rather than I did it for them which was the way I used to do. Now, I return the responsibility of learning back to kids. I provide guides only when they really need help……."
(Teacher #1)

"……I have to emphasize that students learned to edit an observation report in life course and they learned writing at the same time. I realized what the deep meaning and the way for students to learn "integration" with confidence. I improve my competency on curriculum integration quite a bit from the experiences of using systems thinking ……."
(Teacher #2)

"……Therefore, what systems thinking taught me is the way of analyzing key elements and interconnection between these elements. Systems thinking makes curriculum/instruction design a lot easier. I am not frustrated (developing curriculum) any more. It also help students a lot for that I will accurately get to the points after I am able to see the forest and see the trees as well……." (Teacher #3)

.   "……The key point is that after learning it (systems thinking), the quality of our dialogues turns into very high. Happy about all these encouraging experiences, our colleagues start thinking about further collaboration among schools, like sharing curriculum frame, supplemental materials, such and such…….What is really amazing is that everybody becomes very active in learning, sharing, and the eagerness toward

learning is really touching. Teachers begin to realize that they benefit a lot from it (systems thinking). We learn not because the administrators say so and so…….Since you learn, consequently, students will like you a lot and always remember that you are a wonderful teacher. The positive attitude of both teacher and students will make a powerful positive loop and, finally, get back to yourself…….." (Teacher #4)

In addition, teachers indicated that the clear goal map helped them in monitoring students' learning and understanding their perceptions and/or misconceptions much better. The teachers also thought that the well-prepared and integrated knowledge on curriculum and instruction assisted them in tailoring the instruction toward students' needs. Teachers' comfort level measured by five closed-ended items in attitude survey showed that teachers felt comfortable about using systems thinking model planning curriculum and instruction and indicated that they enjoyed having an opportunity to use this methodology and would like to introduce to other colleagues(Table 3). At the same time, most teachers indicated that the principal's support and someone's leadership (not necessary the academic administrator) played as the engine to make organization learning worked which never well did before. In this study, the major engines were teacher #1 in school A; a group of six 2nd grade teachers in school C; the academic administrators in school B, D, & E; and the principal in school F.

Table 3 Results of teachers' responses on comfort level using the model

Questions	Mean	Standard Deviation
1. I felt comfortable using systems thinking model before training.	2.05	0.09
2. I felt comfortable using systems thinking model after training.	4.45	0.38
3. I found the turnouts of using systems thinking model to design curriculum/instruction were encouraging.	4.50	0.40
3. I would like to introduce the methodology to colleagues.	4.07	0.53

N = 363

5 - Point scale with

5: Strongly agree, 4: Agree, 3: Undecided, 2 : Disagree, and 1: Strongly disagree

CONCLUSIONS AND FUTURE RESEARCH

Several conclusions can be made based on the results of this study.

The evaluation results of this study suggest that a great promise of systems thinking in their ability to transform schools to a learning organization in which teacher collaboratively involvement and participation to develop integrated curriculum are possible. Oftentimes the newness and novelty of an innovation makes administrators or teachers think that they must spend much more time and put lot efforts. This assumptive thought prevents them from trying to change. This issue has implications for both administrator/teacher professional development and school improvement plans to function as a whole.

The results of the study also indicates that systems thinking not only can increase the quality of administrator-teacher and teacher-teacher interaction, teacher curriculum and instruction planning, continuous assessment of curriculum and instruction, immediate and formative feedback, but can also decrease overall time/load required on task of curriculum/instruction in the long run. At the same time, design curriculum/instruction with more accountability and higher quality.

However, innovation is not always easy for either administrators or teachers, especially not easy in the beginning. Before innovation, a mechanism needed to be well prepared and gradually formed beforehand because administrators and teachers must have the opportunity to learn how the innovation or new methods can make their professional development better and easier under the stress of regular work load. Given the characteristics of organization learning in systems thinking, this is hard to learn solely by self-learning. In addition, the results of this study suggest that lecture-style training may not be effective in helping administrators or teachers to enhance competency to successfully integrate them into their curriculum/instruction planning. An approach with a feasible schedule that focuses on hands-on experiences and ongoing dialogues/supports among peers, administrators, mentors, experts and even the community might be more successful.

Future implementation of systems thinking model need more systems thinkers as facilitators involved. They could be principals, academic administrators, or teachers to improve current part-operation systems thinking in schools. In terms of research methodology, the ultimate concern for future research is to test the model by applying alternative tools to develop more effective curriculum/instruction strategies and construct better model.

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