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# Effectiveness of Simple to Complex Sequences and Composition Instructional Strategies in Learning and Retention of Concept of Experimental Science in Secondary School

**Yousef Rezapour**
Assistant Professor of Educational Sciences, University of Tabriz, Tabriz, Iran
and
**Kiumars Taghipour**∗(corresponding author)
PhD student of Instructional Technology, Tarbiat Modarres University, Tehran, Iran
Kiumars.taghipour@modares.ac.ir

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**Abstract**

The present study aimed to investigates the impact of simple to complex sequencing strategies and composition on the learning and retention of concepts of experimental science lesson in secondary school. In this study, two groups of semi-experimental design with pre-test and post-test were used. Statistical population was all second year male students of public schools of Kaleibar city in school year of 2000-2001. From this community, with a multi-stage cluster sampling method, two classes were selected as samples. In this study to assess subjects, academic achievement test was used and to assess its validity the opinions of scholars, related experts, and the two dimensional table of content-aim is used and the reliability of measuring instrument by the correlation between two halves of pre-test and post- test is obtained 0/83 and 0/84 respectively. The research procedure was in this way that the experimental group was trained the chapter 13 of experimental science book of secondary school by using of simple to complex sequencing strategies and composition and control groups received the same chapter through the traditional teaching method. At the end, after performing a post-test and analysis of covariance of obtained data, it was found that, there was a significant difference between learning rate of experimental and control groups in experimental science lesson and experimental group meet better learning and the results showed that students in the experimental group compared to the control group performed better in post-test of retention.

**Key words:** simple to complex sequencing, composition, learning, retention

## Introduction

Most of students' learning in country's educational system, in some of the courses especially in experimental sciences at various levels was surface such that they are not able to learn significantly and understand the relationships between ideas. As a proof for this claim, results assessment of international test of science and math 2007 and academic achievement tests have high level of learning goals that in those, Iranian students were not successful. Researches in this area have been done in order to determine the reasons for students' lack of academic achievement and results showed that one of the effective factors on learning and academic achievement of learners refers to teaching quality and how to deliver lesson (education). Explicitly expression of objectives, expression of lessons in explicit and understandable language, presenting lesson in a structured and systematic way, student's being active during the training and connecting new content with the students' prior knowledge, in addition to enhance the quality of teaching and providing training, increase student learning too. And existence of an educational model that has all these elements, can reach current situation to the optimal extent (Birmipor and Liyaghat Dar, 2009). Mentioned

components have been confirmed by scholars of education. According to Bruner (1966) training sequence through structured manner, has affected students ability in absorbing and transferring learning. He also emphasized the importance of understanding the structure of subject of lesson which by learning that, learners are able to understand the relationships between elements of content. In addition to Bruner, Azobel (1968) another cognitive theorist, states his basic idea as follows that significant learning happens by keeping relation between concepts and new topics through structure of cognitive learning. This aim will be achieved in the light of providing education from total to component (Mayer, 1980). In this regard Reigeluth (2009) also states that providing education in organized manner affects learning, retention and motivation of learners. Currently, the idea of creating meaningful learning in all lessons, especially empirical science is stressed by educational experts. Since experimental science due to the including concepts and principles, and also because of close relationship of its issues with learners daily life, provides for them a considerable help in recognition of environmental phenomena, so teaching this lesson in traditional way to live in today's world would not be helpful for students. In traditional learning, topic of lesson are divided into simpler parts and each part is taught separately and then at the end of training, all the components are placed together without understand the relationships between the components. In order to solve this problem, theorists have suggested that learners should be lead with effective training methods to understand the course structure and exploring the relations between available ideas in course, in order to acquire the ability of solving unknown issues of future. In order to accomplish this important goal, a variety of corrective approaches such as applying simple to complex sequencing strategies and composition is emphasized. In this regard, Reigeluth (1983) suggests that educational design deals with prescription of appropriate educational methods according to results and educational circumstances to create effective education. According to him, training is started with presenting the outlook or overall prospect of instructional content, and gradually course content is described and expanded. Reigeluth uses allegory of zoom lens camera to facilitate understanding of how of this type of training. As a zoom lens camera can give a comprehensive picture and without detailed reflection, course "outlook" too suggest a general and comprehensive picture of all training without considering the details. After presenting an "outlook", the camera can focus on any part of the scene or landscape that this work makes clear the details of a corner of the image to the viewer. (Reigeluth calls this act expansion and description) and then camera returns to comprehensive and overall outlook and, thereby, learner understands the relationship of learned topics with the whole subject of education. Camera's focused moves and returns to whole picture (outlook) will continue until all issues are proposed (Fardanesh, 2007). The above description of the training mostly implies the simple to the complex sequence strategy of training (for original structure of the course) that the composition strategy also takes into consideration in this sequence in order to facilitate understanding of structure of lesson subject by the learners. According to Reigeluth's idea, the first step in instructional design involves determining the type of educational content and its constituents. Based on this Reigeluth generally, divides the educational topics into two categories: theoretical issues and practical issues. According to him when educational content explains the performance of a matter or methods of crop production, or the steps necessary to accomplish a work, it is called practical issues. Here the components of the education refer to the same steps of performing work or steps of crop production and theoretical issues point to all the academic data and in all areas (concepts and rules) that itself is divided into conceptual issues or legal issues by focusing on the main core of educational content. In his view, after choosing one of the three types of content - concepts, working methods, principles – will be decided on the structure of desired issue. (Reigeluth and Stein, 1983). Knowledge structure

shows the relationship between parts and pieces of knowledge (e.g, such as facts, concepts, principles, methods). Based on the type of educational topic, it is necessary to identify the concept structure and method or theory of work in order to start the work of sequencing design. A designer can expand and describe learnable ideas with simple to complex sequence according to the main types of knowledge structure, (Reigeluth, 1999). Simple to complex sequence is applied to main structure of a period and for curriculum. This strategy provides a simple and general education and an outlook or prospect of main topic of educational content and in the following of training gradually deals with more expansion and description of topic (Anglish and Reigeluth, 1995). Simple to complex sequence is done differently depending on the content type. Accordingly, the sequence of simple to complex is used in different terms of conceptual sequencing, theoretical sequencing and sequence of procedure. If the content is related to the procedure (practical issue) display of working constitutes the "outlook" in the simplest and most general possible way. If the content is related to conceptual type, statement of that concept with mentioning its special features, along with an entirely rational and clear example points to the "outlook" of program. If the content is related to a legal type, rule presentation in easiest and most comprehensive way is the same outlook. Simple to complex sequence includes the outlook initially and elaborate on the content of education gradually. Outlook or overall prospect requires presenting small number of ideas in practical, significant and objective level. The rest of the course content provides more elaboration on the available content in outlook (Reigeluth, 1983). Educational is done in various steps or levels. Each level provides further elaboration on components than the previous levels. In this case, in first level the content expansion which presented in lesson outlook is elaborated and the second level is elaborated on the organizational content which presented in first level and education continues in this way until reaches to a desired level of complexity.

In simple to complex sequence, educational content can be taught expounded one of two ways of "normal sequence" or "spiral sequence".

Composition strategy due to the statement of relation among educational parts and facilitating the learning of these subjects by comparing them with each other and correlation of these issues with the learners' prior knowledge enhance learning and reminding. Reigeluth (1983) suggests presentation of "composition" in education (Fardanesh, 2007). Mentioned strategy is used to create the relationship and integration of content's types (concepts, principles, or procedure) which includes the following components:

1. Presenting a generalization in figure 1or some knowledge structures (Fig. diagram), and if it is necessary to describe or verbal description (prose) is added to it too.
2. Presenting some examples that represents the relationship between ideas.
3. Providing some self-assessment and diagnostic test.

Learners achieve meaningful learning by the help of this strategy, through relating new information to prior knowledge and understanding the interrelationships between different learning components. Composition put the separated pieces of knowledge in a whole picture and provides a combined understanding of them. Therefore, the composition strategy as a part of education can help learners to understand the relationships between pieces of learning in order to learn each piece of learning in a meaningful context.

Elaboration theory uses two type of composition in education:

1. Internal or topical composition: is used at the end of each lesson and to show relations between newly learned ideas in that lesson.

2. The overall composition: shows the relations among the learned ideas in new lesson and the previous lesson. These two types of composition come at the end of each lesson (ibid.).

Main and secondary components of circulation systems of material are as follows: The type of relation among the main and secondary components of material circulation systems with each other is like blood circulation in the body.All bloods (as a carrying liquid by vessels) with carbon dioxide enters to right atrium of heart through upper large vein and down large vein, then these bloods pour into the right ventricle through the valve between the right atria and right ventricle (tricuspid valve).With contraction operation of right ventricular, right ventricle's blood pass from pulmonary artery valve with pressure into the pulmonary artery in order to transport blood into the lungs, and gas exchange occurs in the lungs and obtained oxygenated blood enter into the left atria through the pulmonary veins. With atrial contraction, all bloods of left atria pass through the valve between the atria and ventricle (two-lettile valve) into the left ventricle. With the left ventricle contraction, left ventricle's blood enter into the aorta by passing from aorta valve and reaches to all parts of the body. Blood flow from the right ventricle to the left atrium is "the small circulation of blood" and from the left ventricle to the right atrium is "the large circulation of blood".

**Self-assessment question**

Can you explain the relationship among main and secondary components of material circulation systems by drawing shapes?

In this way, new ideas are put into the context of previous training and through composition process; learners will be constantly aware of ideas structure in the course and relationship of each component of the knowledge with the related components (Reigeluth, 1983). In general, providing the composition in education has the following results:

1. Confront student with a valuable knowledge. 2. Facilitate the deep understanding of individual ideas through comparison. 3. Increase its meaningful learning and attractive motivation and 4. Increase retention through relating new knowledge with prior knowledge (Fan, China, 2002).

**Background of research**

As explained, according to Reigeluth's perspective the main educational strategy refers to a sequence of simple to complex. Content sequencing was considered since the scientists were aware of the importance of lesson subject structure as a key educational variable, and attracted much attention during the 1960s as an important aspect of educational material program. This strategy was based on theoretical and experimental background of different scientists such as Bruner and Ausubel. In this regard, study of Brown (1970) indicates that sequencing the complex problem solving behaviors such as complex cognitive skills significantly effect on large and long lesson plans. Landstrom (1970) in another similar study considered the effect of sequencing strategies at the macro level on center of elaboration theory on learning of text material and reached to this conclusion that the sequencing improves learning and retention of text material. James Quinn (1994)in a research entitled operation of educational elaboration theory in learning of Japanese language considered the effect of sequencing on learning of Japanese grammatical concepts and concluded that learners who received Japanese grammatical concepts through simple to complex sequences had better performance than learners who learned these concepts through conventional sequencing methods. In addition to sequencing strategy, composition strategy has also been used to understand the relationships among ideas by learners. When many teachers felt that providing composition reinforce the quality of education, this strategy attracted much attention. Since its creation, separate studies have been conducted such as study of Carson and Reigeluth (1983) who found that the relationships between concepts with providing composition at the end of whole to component sequence of education to be learned better than providing

composition at the beginning of education. In addition to this, the findings of Frey and Reigeluth (1981) showed that the composition, in better learning of concepts is effective than providing education without composition. Research conducted by Frey and Reigeluth (1983 & 1981), Reigeluth and Carson (1983) were examined the effect of different positions of conceptual composition in relation to sequencing strategy. However both of them used tree chart diagram as a template for conceptual compositions. But "template" was not precisely examined in terms of its changes effects. The first study on "template" was done by Mclean, Yah , & Reigeluth (1983) entitled " Examining the effectiveness of composition template on conceptual learning" and effectiveness of three templates of conceptual composition was evaluated: 1. Tree chart diagram (only visual), 2. Prose template (only verbal), 3. Template of diagram and prose composition (visual and verbal). The result showed that when conceptual relations to be taught, "Visual template" had preference in relations learning than the verbal template or combination of verbal and visual. It is worth to note that, none of the above studies did not follow administration of sections (items) of composition structure.

Instead of having generalizations, examples and exercises in composition, they only investigated into generalizations. Therefore the results of these investigations are in connection with the "position" of composition in a lesson or the "template" of generalization's composition element instead of entire composition structure.

In another study, James Edward (1983) has examined the effectiveness of sequences and conceptual compositions and procedure on specific educational outcomes. Sequencing strategies included whole to component sequence of concepts and simple to complex sequence, and composition strategies included provide internal composition during the education, provide compositions before and after education. In a way that all composition strategies were as the visual representation of relationships between the content, that were defined as a hierarchy of concept and procedures flowchart. Educational outcomes including students' ability to recall and apply generalization and research hypothesis supervises that students receive composition in their education perform better in applying generalization than those who don't use this strategy. Results showed that there is any significant difference among groups in achieving educational goals. On the one hand, Chao and Reigeluth (1986) in a study examined the impact of different composition structures and templates of generalization's element on levels of remembering and application of learning. Their procedure was in this manner that four groups with combining of two type of composition structures (complete versus incomplete) with two type of generalization's template (verbal vs. visual expression) were formed, and results showed that the generalization's template didn't have significant impact on levels of remembering and application, and composition for remember of learning has had a positive effect. When the groups were compared with the control group, the results showed that the complete composition (with generalization, examples and exercises) is more effective in better learning than providing education without composition. Based on this background, the main research question referred to whether simple to complex sequencing strategies and compositions have any effect on learning and retention rate of experimental science concepts in secondary school?

## Methodology

Due to the proposed nature, purpose and hypotheses, this study refers to the quasi-experimental research type with pre-test and post-test design and with control group.

### *Subjects*

Statistical population were all second year male students of public secondary schools of Kaleibar

city in school year of 2000-2001. From this community, with a multi-stage cluster sampling method, among schools of this city, a school with 40 students of secondary school, and two classes were selected for the implementation of the test.

***Tools for data collection***

This study aimed to assess subjects' learning and retention rate by achievement tests. Thus, the chapter 13 of experimental science book of secondary school with the title of "material circulation" was selected for teaching and then two multiple-choice tests with 34 questions designed. The first sample is considered as pre-test and second sample as post-test. The reliability of these tests by the correlation between two halves is obtained 0/83 and 0/84, respectively.

***Treatment***

Treatment was conducted in a way that at first desired strategies must be instructed to teachers (same teacher in each group) and based on that he can transfer lesson's content to students in class. So, researchers elaborated strategies of simple to complex sequence and compositions to related teacher. For correct implementation of this method, a pamphlet entitled education with strategy of simple to complex sequence and compositions (was authored by researchers), also plan of lesson's chapter "material circulation" according to this strategies (that investigators had gathered and designed in collaboration with subject specialists) was given to related teacher and his consciousness raised with clarification of strategy and lesson plans. After teacher's preparation, teaching began since late fall of 2011. A pre-test was conducted before training to determine prior knowledge of the students in both classes. After collecting the results of the pre-test, the chapter 13 of experimental science book, which is one of the most important topics, was taught by the teacher for two weeks (two sessions per week). Finally, at the last session of teaching, learning post-test was given to students and three weeks after completion of the training, the second post-test (retention test) was given to students to measure their retention of taught concepts.

**Results**

After data collection, for analysis of gathered data, descriptive and inferential statistical methods were used in this study. For descriptive statistic, methods such as mean, standard deviation were used and statistical method of covariance analysis was used to analyze significant differences between the two groups in the learning and retention rate.

**Table 1. Descriptive index of pre-test score, learning post-test and retention post-test of each group (trained with the strategy of "simple to complex sequence and composition" and traditional education).**

| Test | Group | N | Mean | SD | Minimum | Maximum |
|---|---|---|---|---|---|---|
| Pretest | Experimental | 20 | 3.48 | 1.10 | 1 | 5 |
| | Control | 20 | 2.84 | 0.79 | 1 | 4.50 |
| Learning post-test | Experimental | 20 | 17.26 | 0.95 | 15 | 19.50 |
| | Control | 20 | 14.70 | 1.88 | 11.25 | 17.50 |
| Retention post-test | Experimental | 20 | 15.31 | 1.35 | 13 | 17.25 |
| | Control | 20 | 13.53 | 1.36 | 11 | 16 |

Table 1 shows pre-test scores, learning post-test and retention post-test of separate groups. Based on indicated results the minimum pre-test score in experimental group is1, the maximum score is 5, with the average of 3.48 and with a standard deviation of 1.10. In control group, the minimum pre-test score is 1, the maximum score is 4.50, with the mean of 2.84 and with a standard deviation of 0.79. The minimum learning post-test score in experimental group is 15, the maximum score is 19.50, with the mean of 17.26 and with standard deviation of 0.95. In control group the minimum learning post-test score is 11.25, the maximum score is17.50, with mean of 14.70 and with standard deviation of 1.88. The minimum retention post-test score in experimental group is 13, the maximum score is 17.25, with mean of 15.31 and with standard deviation of 1.35. In control group the minimum retention score is 11, the maximum score is16, with mean of 13.53 and with a standard deviation of 1.36.

**H1**: Instructional strategies of simple to complex sequences and compositions are effective on students' learning of experimental science lesson in secondary school.

For analyzing the data related to this hypothesis, based on covariance analysis method, at first its essential assumptions namely being identical the homogeneity of variance and regression line slope of groups are examined. Then, the results of covariance analysis of learning post-test scores are offered.

**Table 2. Results of analysis of the same regression line.**

| Source of Variation | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Pretest | 4.087 | 1 | 4.087 | .1.911 | 0.175 |
| Pretest * Group | 5.55 | 2 | 5.55 | 2.59 | 0.116 |
| Error | 76.98 | 36 | 2.139 | | |
| Total | 10366.062 | 40 | | | |

In the above table, the results of ANCOVA is given as default of covariance analysis. Based on the results, the significant level (P=.116) is greater than 0/05. Therefore, the assumption of homogeneity of regression is achieved.

**Table 3. Results of Levene's test for examining the homogeneity of variances**

| F | df1 | df2 | Sig. |
|---|---|---|---|
| .12 | 1 | 38 | .851 |

According to table 3, the results indicated that the homogeneity of variances is established in two groups. Because the F value of 0.12 is not significant at level of 0.05 because this significant level is much greater than the significant level of 0.05. Therefore, we can conclude that the error variances of two groups are equal.

Table 4 shows the results of covariance analysis of students' learning post-test score after treatment. According to the results indicated in the table ($F = 23.379$; $df = 1, 37$; $p < 0.01$), when the effect of pre-test on groups' post-test results is removed , the difference between groups at significant level of 99% confidence is significant. Thus, with 99% confidence, we can say that

instructional strategies of simple to complex sequence and compositions are effective on students' experimental science learning in secondary school.

**Table 4. Results of ANCOVA for posttest score among the learning group after the treatment**

| Source of Variation | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Pretest | 1.840 | 1 | 1.840 | .825 | .370 |
| Posttest* Group | 52.156 | 1 | 52.156 | 23.37 | .000 |
| Error | 82.545 | 37 | 2.231 | | |
| Total | 10366.062 | 40 | | | |

**H2:** Instructional strategies of simple to complex sequences and composition are effective on students' retention of experimental science lesson in secondary school.

For data analysis relevant to this hypothesis, the following statistics were done.

**Table 5. Results of analysis of the same regression line**

| Source of Variation | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Pretest | 14.632 | 1 | 14.634 | 9.630 | .004 |
| Pretest * Group | 4.167 | 2 | 4.167 | 2.743 | .106 |
| Error | 54.705 | 36 | 1.520 | | |
| Total | 8424.875 | 40 | | | |

Table 5 show the results of analysis of the same regression line as covariance analysis default. Based on the results, the significant level of interaction effect (P = .106) is greater than 0/05. Therefore, the hypothesis of homogeneity of regression is accepted

In order to see the equality of the error variance of two groups, the data were analyzed as follows**.**

**Table 6. Results of Levene's test for examining the homogeneity of variances**

| F | df1 | df2 | Sig. |
|---|---|---|---|
| .214 | 1 | 38 | .646 |

Table 6 indicates the results of Levene's test for examining the homogeneity of variances. Based on the results indicated in the above table, it can be seen that homogeneity of variances was confirmed between two groups because the amount of Levene's F-test (.214) is not significant at level of 0.05 (P=.646). Therefore, the error variances of two groups are equal.

**Table 7. Results of ANCOVA for posttest score among retention group after the treatment**

| Source of Variation | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Pretest | .805 | 1 | .805 | .429 | .516 |
| Posttest* Group | 25.163 | 1 | 25.163 | 13.427 | .001 |
| Error | 69.339 | 37 | 1.874 | | |
| Total | 8424.875 | 40 | | | |

Table 7 shows the results of ANCOVA for the students' retention post-test score after treatment. According to the results indicated in the above table ($F=13.427$; $df=1,37$ ; $p<0.01$), when the effect of pre-test on groups' post-test results is removed , the difference between groups at significant level of 99% confidence is significant. Thus, with 99% confidence, we can say that instructional strategies of simple to complex sequence and compositions are effective on students' experimental science learning in secondary school.

**Discussion and conclusion**

According to the traditional design of educational systems, content teaching begins with an appropriate level of complexity which is recognized teacher and this trend continues in a state of pieces without returning to a lower level of complexity. Consequently this kind of teaching, learners cannot reach to an effective learning and retention. Due to the inefficiency of these methods in teaching structured courses, scholars and experts and educational researchers recommend teachers to use instructional strategies for creation and strengthening of learning and meaningful understanding. Among these can be point to the strategies of simple to complex sequence and compositions that because of its high functionality in facilitating teaching and learning process has been always approved by theoretical and empirical researches. When education was organized in a simple to complex way, learners' understanding power increases. According to this organization, providing a general perspective in beginning of new content teaching, acts in the role of Azobel's pre-organizer that provides a scaffold and framework for learner and the following information can well establish on it. In a way that through creation and reinforcement of a stable and complete structure understanding lead to their meaningful learning. In addition to the sequence strategy, the composition strategy is also used in order to understand the relationships between ideas by learners. By looking at it from the viewpoint of the information processing theory, which suggest that the composition is very important, because it helps learners achieve significant learning by relating new information to prior knowledge and understanding the relationships between different pieces of learning. Composition puts separate pieces of knowledge in a whole picture and provides a combination understanding of them. Thus, the composition strategy as a part of education can help learners to understand the relationships between pieces of learning so that each learning piece has been learned in a meaningful context.

Based on these capabilities, present research was done regarding the effectiveness of simple to complex sequence and composition strategies on learning and retention of experimental science lesson at secondary school and results indicate that using of these strategies in learning and retention of experimental science lesson has positive effect. To confirm this hypothesis, it can be said that

each educational policy that can be effective in activating learners' previous learning and knowledge will improve learning and retention. Providing a general perspective of course content at the beginning of the educational sequence, create a clear, stable and organized structure understanding in students' mind. Consequently, through formation of this structure meaningful learning of new content happen. Also, when students' learning are meaningful, content will remains in their memory for a long time. In this regard, a similar study by Carson and Reigeluth (1983) carried out with the conclusion that "relations between the concepts by presenting composition at the end of whole to component educational sequence are learned better than providing composition at the beginning of education.", approve the results obtained from this study. Additionally, results of some researches such as research of Haykovin (1994), Landstrom (1990), Frey and Reigeluth (1983 and 1981), Chao & Reigeluth (1986), and Mclean & Reigeluth (1983) are consistent With results of present study. Obtained results emphasized the need to reform the lesson subject's structure of experimental science by compilation organization and educational textbooks and use of instructional methods that cause meaningful learning in teaching of experimental science's content.

**References**

Beyrami Por A., Liyaghatdar, M. J. (2009), Determining the quality of math teaching in fourth grade of elementary school students in Isfahan in order to provide solutions for better performance of students in Thames's International test, *Journal of education*, 20 (4).

Fardanesh, H. (2007). *Theoretical principles of educational technology*, SAMT Publication, Tehran.

Brown,J.L.(1970). Effects of logical and acrambled sequences in mathematical materials on learning with programmed instruction materials. Journal of Educational Psychology.61,41 -45.

Carson,C.H.,& Reigeluth,C.M.(1983). The effects of sequence and synthesis on concept learning using a parts-conceptual structure. IDD & E Working Papers, NO.8.Syracus,NY: Syracuse University School of Education. ERIC:NO. ED288518..

Chao, Ch.I, & Reigeluth,C.M.(1986). The effects of format and structure of a synthesizer on procedure – decision learning. *IDD&E Working Paper*, 22. Syracuse University.,N.Y. School of Education.

Chiemi.N, & Quinn.J.(1994). *The Application of Elaboration theory of instruction to Japanese language Education*. PhD dissertation, Utah state university.

English.R.E, & Reigeluth.C.M.(1995).*Formative research on sequencing instruction with The Elaboration Theory*. Indiana State University. Reports-Research/ Technical. ED 388 668.

Frey,L., & Reigeluth,C.M.(1981). The use of sequence and synthesis for teavhing concepts. *IDD & E Working Papers*, No.5. Syracuse, NY: Syracuse University School of Education.ERIC: NO.217859.

Jackson, R.G. (1983). *The effects of conceptual and procedural sequences synthesizer on selected outcomes of instruction*. Doctoral Dissertation,The Pennsylvania State University.AAT 9326867.

Landstrom, D.R.(1990). *A comparison of elaboration vs. Linear-hierarchical macro-sequencing of text on the retention and transfer of knowledge in short units of instructional text*. Doctoral Dissertation, Utah state university.

Mclean. L.,Yah , & Reigeluth.C.M.(1983). *The effects of format of synthesizer on conceptual learning*, IDD&E working Paper No. 13), Syracuse university, Syracuse. NY.

Mayer. R. E. (1980). *An evaluation of the elaboration model of instruction from the perspective of assimilation theory*. U.S. Department of education.

Reigeluth, C.M. (1997). Instructional Theory, Practitioner Needs, and New Directions:Some Reflections, *Educational Technology, (37)*1, 42-47.

Reigeluth,C.M.(1999).The Elaboration theory: Guidance for scope and sequence decision.In C.Reigeluth(Ed).*Instructional-Design Theories and Models*(Vol..II).NJ: Lawrance, Erlbaum Associates.

Reigeluth, C.M., & Carr-Chellman,A.(Ed.)( 2009). Instructional-design theories and models, volume III: Buillding common knowledge base Rutledge ,NY10016.

Reigeluth,C.M.(1979). In search of a better way to organize instruction: The Elaboration theory. *Journal of instructional Development*, 2, 8-15.

Reigeluth,C.M.& Stein,F.S.(1983).The elaboration theory of instruction. In C.M. Reigeluth(Ed.), *Instructional design theories and models: An overview of their current status* (335 - 381). Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Reigeluth.C.M.(1999). Elaborating the Elaboration Theory. *ETR&D,*40(3),80-86.