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# Factors to Affect Descriptions on Intra-concept Relation in Introductory Concept Mapping

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**Abstract.** Introductory Concept mapping is a method that property of association task is introduced to Concept Mapping. With a certain extent of freedom permitted to experiment participants for association, the method is advantageous in that motivation of participants to construct maps is enhanced higher than Concept Mapping. Experiment participants are supposed to write down concepts which are associated from the concept of developmental psychology around the word, “developmental psychology”, written on a white paper. In an examination of correlation coefficient based on this method using score of intra-concept relation explanation as a dependent variable and previous (existing) knowledge score, number of mean expressed concepts, number of bifurcated concepts, number of cross-links, and number of forward reactions as independent variables, significant positive correlation was observed with all independent variables except for the number of cross-links. In addition, only number of bifurcated concepts and previous knowledge score remained as reasonable independent variable by a multi-regression analysis performed based on stepwise way.

**Keywords:** **Keywords:** Concept Map, association task, Introductory Concept Map, relation of concepts

## 1 Introduction

Concept Mapping is an externalizing strategy for a cognitive structure developed by Novak & Gowin (1984) based on a learning theory of Ausubel (1968) as well as a learning strategy for forming more reasonable cognitive structure.

adfa, p. 1, 2011.

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With a focus put on a strict systematicity between concepts, in particular, hierarchical systematicity reaching from subordinate to superordinate concept among others, Novak et al. included links between concepts as well as explanation (linking label) described on the links as elements of concept map using a material of science education. Concepts to be written, way of linking, and linking label is strictly determined in the corresponding unit.

However, it was revealed in the subsequent development that non-hierarchical map could exist, and Novak himself proposed to perform association task in the course of introduction of concept map to learning. Further subsequently, even such opinion has also appeared in Japan that association task itself should be taken as a concept map resulting in diffusing the very meaning of the concept itself in a form of concept map.

There have been pros and cons regarding association task. For example, Cachapuz & Maskill (1987) performed association task in order to examine intra-concept relation held by subjects. As the result, it has been proved that there is a large difference between experts and beginners using a diagram with less cognitive load and an easily viewable method. At the same time, Cachapuz et al. have criticized such strategy that describes intra-concept relation in detail is a very time-consuming method. On the other hand, Stewart (1979, 1980) and Shinkai (1981) have criticized regarding association task that how subjects thought to link between concepts is unclear.

In the author's series of experiments, showing association task graphically really has an advantage to keep cognitive load lower and it is possible to assume how subjects thought to link between concepts as long as they are able to endure strict experiment, but it has been proved that such strategy as to memorize the whole things of typical maps is used by subjects who have in-adequate previous knowledge or who are judged to lack of learning motivation required for understanding intra-concept relation. Therefore, it is desired to describe link-labels in detail from a perspective of learning support which is the true purpose of Concept Mapping. However, it has been revealed that when making subjects with less knowledge describe link-labels on the map during the experiment they get confused by the time consumed to think how to describe them resulting in great decrease in number of concepts to be de-scribed.

Amid such trend, Minagawa (2009) figured out a way to positively utilize association task by revising it. With appearance of various factors observed in association task similarly to a case of concept map, such as hierarchical property, concept bifurcation phenomenon (a few subordinate concepts to be bifurcated from specific concept and described), and cross-linking (a new relationship between subordinate concepts to be recognized after completing hierarchical upper and lower structures), it has been proved to be possible to obtain clues for recognizing cognitive structure of learners by rather considering these observation results and association task as such meaning has become to be called as "Introductory Concept Mapping."

Practically in this method, learners are handed over with a sheet of white paper and asked to write original concept for association on the center of it and additionally write down concepts associated from the original one in order. This

method has characteristics such as

- ① to describe related concepts consecutively without caring for hierarchical intra-concept relation,
- ② to note re-called order by numbers,
- ③ to continuously describe concepts group in a direction free from the original concept for association at the center, and
- ④ to describe link-labels too similarly to a case of Concept Mapping, and it also demands efforts to find out cross links asking to describe link-labels too in principle in such a case. However, as it often becomes to be extremely complicated, such link-label and numbers to indicate order are often omitted. In this study, Minagawa has demonstrated in a multi-regression analysis using a test score of the corresponding field as the dependent variable that numbers of concept bifurcation and cross-linking are useful as independent variables. Fig.1 and Fig.2 below are examples of ordinary concept map and introductory concept map, respectively.

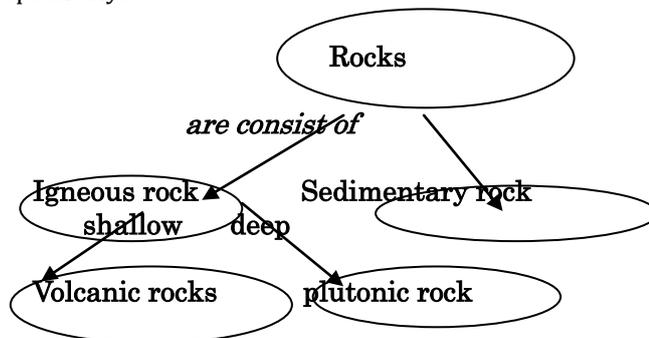


Fig. 1 An example of the Concept Map, "Rock"

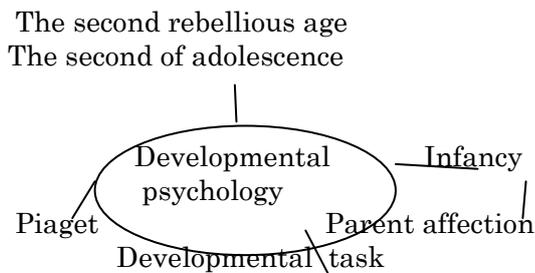


Fig. 2 An example of the Introductory Concept Map, "Developmental Psychology"

Then, why hierarchical property was not necessarily demanded between associated words groups in the Introductory Concept Mapping is based on a fact that recalled order of concept groups in association is random to some extent. That is, for example, in a concept of Ausubel's meaningful learning, subordinate concepts are believed to consist of systematization with several concepts and refining for which meaningfulness, understanding with profound contents and correlation are considered.

What is important is that association is not necessarily developed from super-ordinate concepts in association task even if subjects systematized them by Concept Mapping. For example, first response word for stimulus word, meaningful learning, may be “meaningfulness.” Further, it may be often developed in order from correlation, refining to understanding with profound contents. Since these examples are often observed in association, any association should be determined to be correct as long as it is within the same super-ordinate concept.

Then, there is a problem of link-label. Link label should be described in detail as much as possible from a perspective of learning support, but it is inappropriate at early stage of unit learning due to tight time constraint. Therefore, adopting intra-concept relation (including a link-label to directly and indirectly link between concepts) as dependent variables in the present study, independent variable and dependent variables were considered from among various possible variables using examples from Minagawa (2009, 2015).

Variables ever considered in the previous studies include posttest score, number of correct associations, number of erroneous associations, total number of associations, number of cross-links, number of bifurcated concepts, related previous knowledge score, score of intra-concept relation explanation, and mean number of expressed concepts per series (total number of associated concepts/number of direct connection)

Of those items, number of erroneous associations and total number of associations were excluded from the study because the former had less importance for interpreting the corresponding experiment and the latter was difficult to be interpreted due to the concurrently included correct and erroneous associations.

As the result, previous knowledge score, score of intra-concept relation explanation, mean number of expressed concepts, number of bifurcated concepts, number of cross-links, and number of correct responses were adopted as variables, among which score of intra-concept relation explanation was used as a dependent variable because it corresponded to a link-label in a broad sense.

Our research hypotheses are as follows:

1. Subjects of the present study may be difficult to function as an independent variable because neither were they able to find out even a few cross-links nor were they instructed how to find out them in a concept mapping practice of previous lectures.
2. Mean number of expressed concepts per series may be difficult to function as an effective independent variable because number of concept maps is originally determined by the types of subordinate concepts.
3. Previous knowledge may work as an effective independent variable this time too because it was able to effectively function every time up to now.
4. Numbers of correct responses and bifurcated concepts may function as effective independent variables because they are indexes whether the whole concept groups is well understood or not.

Experiments are performed and the results are considered in order to verify these hypotheses.

## 2 Methods

1. Experiment participants: Totally 26 sophomores including 2 men and 24 women of B department in a private A university in Okayama prefecture
2. Date of experiment: December in 2014]
3. Venue of experiment: Class room within A university
4. Procedures: We performed a previous knowledge survey (scale of one to ten) a week before the experiment and a relation explanation test (scale of one to ten) a week after them without preliminary notice for both of them. The experiment was performed in a lecture of “Developmental psychology” as a part of class. First, students were handed with a sheet of A4 size white paper and instructed as follows: “We perform an association experiment now. Fill in your affiliation, student ID number and name at the top of the form. As a word “Developmental psychology” is written at the center, write down words associated from the word in order you associated in a manner to connect them. In order to make the order of associated words clear, draw lines from the origin word for association to those associated. Also note numbers to indicate the order of association. You don’t need to write link-label. You are allowed to use 30 minutes for writing. Then, let’s get started!” Then, instructing, “Stop!” after 30 minutes elapsed, the forms were collected.

## 3. Results

Table 1 Mean and standard deviation of each variable.

	<i>M</i>	<i>S</i>
related explanation score (max. =10)	3.4	2.6
remembrance concepts/ connection	3.1	1.3
number of positive reactions	35.6	11.3
number of branches	3.9	3.9
cross-links	0.5	1.2
prior knowledge score(max=10)	5.6	1.9

\* $p < .05$ , \*\* $p < .01$

Table 3 Standard regression coefficient  $\beta$  of the number of branch and the preceding knowledge, score

	$\beta$	$t$	$p$	VIF
number of branches	.44	2.69	.013	1.571
prior knowledge	.43	2.63	.015	1.571

A multi-regression analysis was performed based on stepwise way using relation explanation score as a dependent variable and number of bifurcated concepts/number of direct connections, number of correct responses, number of cross-links, and previous knowledge survey score as independent variables. Mean value and standard deviation of each variable is shown in Table 1. Correlation coefficients between each variable are shown in Table 2. In addition, Table 3 shows bifurcation number, standard partial regression coefficient  $\beta$  of previous knowledge, as well as significance probability  $p$  of  $t$  and  $VIF$ .

#### 4. Discussion

Positive reaction counts refer to the appropriate number of vocabulary associated with conceptual relationship. It is a high number in considering the limited time of 30 minutes which indicates that students are keeping the memory of the study contents for a long time.

On the other hand, Table 1 indicates that students do not have a deep understanding of intentional and extensional concepts as well as conceptual relationship despite of their low relative explanation score. In comparison with a concept divergent and a regular concept mapping, the introductory concept mapping (ICM) enables us to theoretically draw unlimited lines that are connected directly to the initial stimulus thereby it is reasonable to say why the number of lines become large. (See Fig.3 and Fig.4).

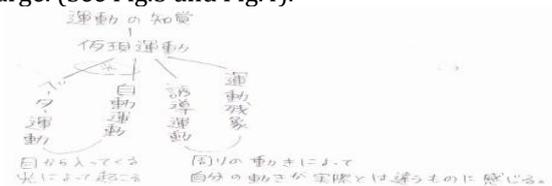


Fig.3 Student A's Concept Map, "apparent movement" in Japanese



Fig.4 Student B's Introductory Concept Map, "Developmental Psychology" in Japanese

Prior knowledge score is consisted of basic knowledge questions and it doesn't provide a high performance. On the other hand, Table 2 shows a significantly high relative explanation score for the prior knowledge, the positive reaction counts as well as the concept divergent just like the previous studies while its correlation for cross-link is low. It is assumed that cross-link was not sufficiently generated as they didn't have enough study contents and time for the course unit in order to discover a new relevance in conceptional relationships. This is why the cross-link was not extracted as a valid variable by multiple regression analysis as shown in Table 3.

Table 2 shows a significantly high relative explanation score for the prior knowledge and the concept divergent just like the previous studies. Because a number of memory concepts divided by a number indicates a high correlation for cross-link, it is assumed that correlation was enhanced due to the high average concepts associated with direct reaction words towards stimulus words. In Minagawa(2009, 2015), cross-link was largely found among students with high academic achievement which is believed due to the correlation of their high academic ability and creativity. However, it is hard to say cross-link happens naturally but requires for a professor to provide sufficient advice or training to students. It is also preferable to have a high motivation for study.

According to Novak et al., cross-link is believed to be an expression of extremely highly abstract thought. Therefore, it can be judged that participants in the present experiment were a bit lack of that aspect, but it may be true in any way that cross-link is the most difficult one to be created.

Among variables for which higher correlation between intra-concept relation is expected, number of bifurcated concepts and previous knowledge remained after a multi-regression analysis for the results of the experiment this time. Quantity and quality of previous knowledge is quite important for connecting intra-concept relation directly. In addition, as it is required for concept bifurcation a good deal of knowledge on what kinds of meanings the given concept can have, this result is believed to be rational.

As it is believed to lead to content understanding support by taking a strategy to instruct about cross-link and the like in advance in addition to recruiting more motivating experiment participants, we intend to study focusing on such aspect in

the future. In this study, sophomore in nursing department were targeted, however, we have done similar experiments with college students in early childhood education department as well. Both majors are directly related to the practice, however, it is believed that proper study for developmental psychology and its theories are required.

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