

# A Tool for Learning of Cognitive Process by Analysis from Exemplar Documents

Wasan Na Chai, Taneth Ruangrajitpakorn, and Thepchai Supnithi

*Language and Semantic Technology Laboratory,*

*National Electronics and Computer Technology Center, Pathumthanee, Thailand*

{wasan.na\_chai,taneth.rua,thechai.sup}@nectec.or.th

**Abstract:** Metacognition is difficult to train, and most of students lack the knowhow to practice it. This work proposes a thought analysis tool from reading to help training in understand logical connections between sentences. The tool allows learners to explicate types of logical expression of the writing article as the example of strategy to convince readers. By analysis and annotating the text in a controlled environment, it is expected that learners can learn from thinking about author's cognitive process, and apply them to think about their own thought and make a strategic planning when they are in a role to write. The tool is designed for learners to assign several kinds of annotations including logical statement type, keyword and logical linking between sentence to the proper writing text by self-analysis under the supervision of coaches. The experiment results show that the tool helps to apparently improve learners' cognitive performance in composing proper essay via the training on analysis reading. In comparison to other sample groups with lecturing and coaching without the tool, the improvement of the tool users was significantly greater in term of logical relatedness, logical completeness and convincible power.

**Keywords:** Metacognition, Concept annotation tool, Explicating thought, Logic learning

## 1. Introduction

Metacognition is a regulatory system involving in understanding and controlling ones' own cognitive performance. Metacognition literally refers to a process of 'thinking about thinking' or 'an ability to know what one knows and what one does not know' (Mahdavi, 2014). Metacognition nurtures ones' ability to think and learn via awareness of how they learn, an evaluation of their learning needs, generating strategies to meet these needs and then implementing the strategies. Developing metacognition is undoubtedly important for learning how to learn and to make use of knowledge/skill. In development of metacognition, metacognition mostly develops with practice (Papaleontiou-Louca, 2003). Harris (2003) pointed out that key elements in developing metacognition including to practice having strategies for planning, monitoring, and evaluating of use.

In practicing metacognition, self-regulation approaches are suggested by letting learners to specify their strategies for planning, monitoring and evaluating their learning. The key is to ask learners to make their thoughts explicit since their vague conceptual thought will be more collected. Besides, making thoughts explicit can cause an intervention of running thought and making learners aware/reflect of their cognition process. There are several implemented tools and teaching strategies elaborating the idea including concept-mapping tool (Chevon, 2014), annotation tools (PJ Rich, M Hannafin, 2009) and wrapper modules to control learning environment. The studies on these works show the sign of development on metacognitive skills.

Metacognition can explicitly be noticed in ones' language usage. The writing essays and articles show author's thought of strategies to convince readers. Furthermore, the use of logical statements is a good manifestation of metacognitive skills since it shows how well learners grapple with and apply their knowledge and skill. This work aims to study the use of control environment by the metacognition training tool in practicing of analysis on logical statement from reading articles. The tool allows users to concept-mapping and annotate logical relations in context as a good example for practicing on using their metacognition. The study in this work is conducted on the effect of learning by analyzing from good examples and their improvement in using the learned skill. The rest of the paper is organized as follows. Section 2 explains a design of the thought analysis tool via reading. Section 3

provides experimental setting, result and discussion. Last, Section 4 gives a summary of the paper and a future plan of the research.

## 2. Tool Design and Usage

This section describes on the design of the tool for controlling environment for practicing metacognition. The thought analysis tool via reading is extended of the tool (W. Na Chai, 2017) for analysis of written articles in terms of logical statement, relation among context and the key concept of the writing. The main focus is for users to analyze the hidden logical relation of the sentence and the method how the author uses to convince readers. Namely, it tasks user to think about what author thinks. By doing so, when the reader turns to be a writer, they are expected to think and to be aware about their cognition in writing process.

The tool provides functions including annotating a keyword (key concept) of a statement, a type of a statements, and indicating how arguments relating to other. With the annotation, hidden relation of logical links of content is explicitly revealed. An overview of the thought analysis tool via reading is show in Figure 1.

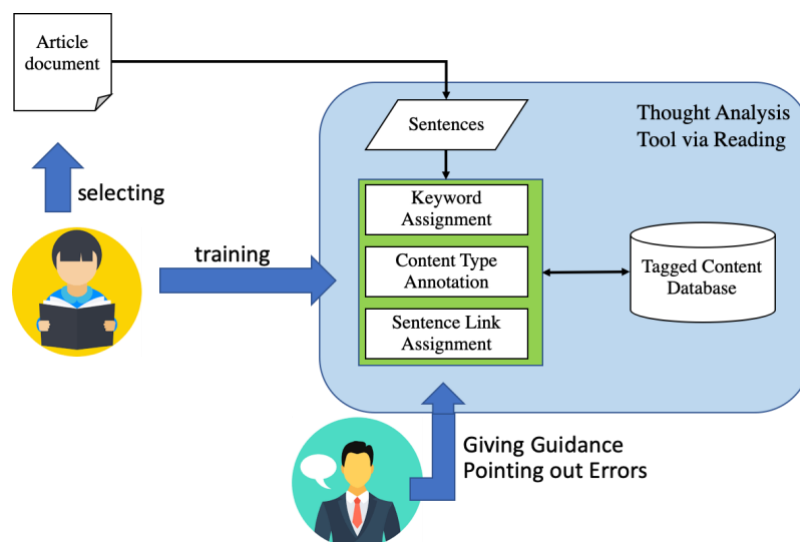


Figure 1. An Overview of the Thought Analysis Tool via Reading

The input of the tool is a text (currently allows Thai and English only) from a writing article. The tool asks users to split their text into a sentence level. The tool then asks users to annotate the sentence regarding logical concepts hidden in the context. The annotation includes keyword (key idea) of the sentence, statement logical type and its link to other sentences. This should reveal the logical strategies of the article author to convince readers towards their goal. Then, the annotation will be reviewed by the coach for guiding towards correction of the annotation. The coach in this tool plays a role of validators of annotation, namely pointing out the incorrect annotation but not giving the correct annotation. With supervision of coach, the learner users will be prevented from misunderstanding and false-belief from shallow thinking and unknowingness.

### 2.1 Keyword Assignment

For each sentence, learner users are asked to provide keyword(s) which they think capable to represent the core concept of the sentence. In assigning keyword(s), users are allowed to fill the box with the term appeared in the sentence context. The number of keywords available for assigning is limited to 1 to 3 terms per sentence. The chosen term can be either a single word or compound words.

This function is designed for users to analyze the terms in the sentence for the most significant representation to the concepts of the sentence. This aims to let users realize importance of term selection regarding contextual appropriateness.

## 2.2 Logical Type of Statement Selection

In this function, a list of logical type is designed to be annotated to the sentence. With exhaustive review on guidelines for writing, many types are given and used in the previous version of the tool (W. Na Chai, 2017). However, the users submit a complain that there are too many types to select on, and some overlaps to other in which causes a difficulty and confusion in selection. In this work, the list is reviewed and revised for the main concepts of logical statement in a two-level hierarchical structure as exemplified in Table 1.

Table 1. A List of Statement Types for Annotation and Their Definition

Type		Definition
Top	Bottom	
General	<ul style="list-style-type: none"> <li>- Declaration of fact</li> <li>- Declaration of opinion</li> </ul>	<ul style="list-style-type: none"> <li>- Statements that relay fact information</li> <li>- Statements that relay opinion information</li> </ul>
Addition	<ul style="list-style-type: none"> <li>- Giving details</li> <li>- Emphasizing</li> </ul>	<ul style="list-style-type: none"> <li>- Statements that provide specific details of core term of other statements</li> <li>- Statements that are restated again to give a sense of significance</li> </ul>
Opposition	<ul style="list-style-type: none"> <li>- Contradict part</li> </ul>	<ul style="list-style-type: none"> <li>- Statements that relay a contradiction of other statements</li> </ul>
Illustration	<ul style="list-style-type: none"> <li>- Giving example</li> <li>- Giving demonstration</li> </ul>	<ul style="list-style-type: none"> <li>- Statements of the actual case/instance of the circumstance in other statements</li> <li>- Statements to demonstrate the circumstance in other statements</li> </ul>
Cause-effect	<ul style="list-style-type: none"> <li>- Cause part</li> <li>- Effect part</li> </ul>	<ul style="list-style-type: none"> <li>- Statements about the cause of the event/incident</li> <li>- Statements about the effect/result of the caused event/incident</li> </ul>
Sequencing	<ul style="list-style-type: none"> <li>- Prior part</li> <li>- Following part</li> </ul>	<ul style="list-style-type: none"> <li>- Statements that occur in prior of a continuous event/incident</li> <li>- Statements that occur in following of a continuous event/incident</li> </ul>
Condition	<ul style="list-style-type: none"> <li>- Condition part</li> <li>- Result part</li> </ul>	<ul style="list-style-type: none"> <li>- Statements about the condition that triggers the event/incident</li> <li>- Statements about the result that is triggered by completing the condition</li> </ul>

Users are asked to assign one of these types to all sentences. Only the types of the bottom are allowed to be annotated. With the types, users are expected to visualize author's implicit method and strategy in convincing readers from the connection of sentence. Users will also learn a pattern of a writing style and look deeper into logic instead of the surface of the content.

## 2.3 Sentence Linking

Relation of sentences indicates the link of thoughts from author's ideas in their work. From observing the proper published articles from genuine sources, we find that most of the sentences are related to form a logical network to convince reader. Thus, we expect reader to learn the relational expression from the good writing.

According to statement types, there is a link between types such as cause and effect. Learners are asked to align the relation to connect the sentence based on their analysis. The assignment of the logical relation is to fill the sentence ID of other sentence(s) regardless of assigned statement types. In case of a new concept unrelated to any previous concepts, users are allowed to assign 'none' to the sentence.

## 2.4 Providing a Summarized Goal of the Article

After all the annotations are made, this function is to ask for a summary concept of the article. Users are asked to give a short summary representing a goal of the reading article. The fill-in box allows up to 250

syllables. This part is important to get the understanding of readers' thought whether they can detect the core of the content after all the annotations are made. This information can help to realize users thought and view about the aim of author which can significantly help learners to concretely establish their own aim when they need to write.

## 2.5 Feedback from Coach

Once learner users submitted their annotations, they are stored into the database. Coaches in this tool have a role to monitor the submitted annotation and to validate them carefully. The coach is asked to provide feedback on the annotations. The options for the feedback 'agree' and 'disagree' while the 'disagree' has the option to provide additional comment on how the coach disagrees on the annotation. Particularly, the coaches are not suggested to give the correct answer directly, but the guidance on how to think to reach that conclusion. This will help to instill the correct cognitive process and the chance for learners to think about their way of thinking.

## 3. Experiments

### 3.1 Experiment Design and Setting

For an overview of this experiment, we aimed to study the effect of the tool in controlling environment for learning of logical analysis. The experiments were to find improvement of learners' metacognition towards the understanding and applicability of convincing writing regarding logical expression usage. The convincing writing was regarded as a realization of goal, strategy to achieve the goal and the performance of the chosen strategy. The learning was conducted by studying from a good example in which in this case was reading the good articles. The testing was measured in the writing from the written essay. A flow of experiment is drawn in Figure 2.

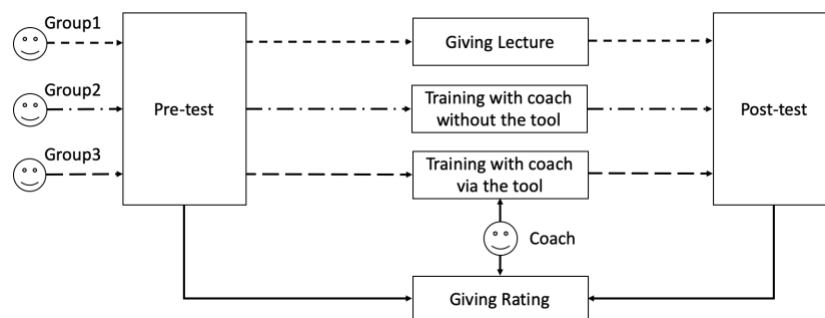


Figure 2. Experiment processes

There were two roles of participants in this experiment. The first is learners, and the second is coaches. Learners were a university Thai student who was a tested subject while coaches took a role of validator who pointed out mistakes from learners and provided guidance in the process. Learner participants were a university undergraduate student. The learner participants were randomly separated into three groups of 15 participants each from a total of 45 learner participants. The three groups were assigned with a different learning process as follows.

- Group1: providing a lecture on the logical analysis from coaches
- Group2: training on analysis with coaches
- Group3: training on analysis via the tool with coaches

For all groups, pre-test and post-test were conducted by asking participants to write an essay of their choice of languages between Thai and English for 400-600 words. The topic of the essay could be chosen from the provided topic-list or by themselves. The topics from the list were a common but meaningful topic such as 'importance of learning English' or 'Definition of superhero in your opinion'. On the other hands, the participant's own topic required an approval from a coach. After the pre-test, Group2 and Group3 had been trained by the coach by choosing and learning from an academic article as an example for 7 days. Meanwhile, participants from Group1 were given a lecture regarding logical

statement in convincing writing. The post-test then was conducted together at the day after the training of Group2 and Group3 were done. As restriction, the topic of the pre-test and post-test for individual could not be the same topic. The essays in blind from both pre-test and post-test were rated in scale of 1 (lowest) to 5 (highest) by three coaches for the aspects given in Table 2. The difference of the rating was a measurement of the improvement.

Table 2. *Focused Aspects for Rating and Definition*

Aspects	Definition and Rating Criteria
relatedness	Checking connection between sentences; the more quantity and quality sentences are correctly logically linked in proper context, the higher rating is given.
keywording	Checking for the using of key terms in sentences; the more proper choose and use, the higher rating is given
completeness	Checking for a completion of statement, i.e. the use of both ‘cause and effect’ or both ‘condition and result’; rating deduction from missing the pair of relation.
overall convincible	Checking the overall convincible of the written essay regarding giving sufficient evidence and reasoning for the statement.

### 3.2 *Experimental Results and Discussion*

From the experiment, the essays from participants were all written in Thai. The average rating results from three coaches of pre-test and post-test were calculated to find the difference. The higher difference of the post-test than the pre-test indicated the improvement of the learner and vice-versa. The results are given in Table 3.

Table 3. *Improvement Result Separated by Groups and Focused Aspects*

Group	relatedness	keywording	completeness	overall convincible	Summation
1	0.09	0.09	-0.11	0.11	0.18
2	0.11	0.78	0.18	0.27	1.33
3	1.27	0.80	1.00	0.96	4.02

The results from Table 3 indicates that the group using the tool (Group3) improves the best for all focused aspects. Group2, who were trained by coaches without the tool, also has an improvement, especially on the keywording aspect. For Group1, there is a little improvement while has a minus score in a completeness aspect. In overall results, Group3 obtains the highest improvement while Group2 comes in second.

These results signify the potential of using the tool to increase users understanding and applicability of their knowledge and skill from practicing via the tool. It is also notable that the students can improve one’s own thinking process by training from analyzing another people thought. They become more realizing of their thinking process and are able to make use of them. By observing the results of the Group3, their post-test essay was full of the complete logical expression and appropriate terms. They were more convincible when comparing with their pre-test. For those students from Group2 who were also trained closely by coaches, their improvement is greatly shown in the selection of key terms in the context, but a few improvements in other aspects. Without the tool to visualize the implicit logical relatedness among sentences, the training alone cannot make learners to conceptualize the logical relation in their cognition. Despite being told, lacking practicing on these aspects results in little to none improvement.

When looking into results based on individuals’ base ability, we obtain the rating improvement results given in Table 4. The ratings for the learners in Group2 and Group3 with low pre-test rating were notably increased; however, the increase was not much for those with pre-test rating higher than 10. This indicates that the training, especially with the tool, works well to those who lacked analysis skill or did not know how to analyze logical relations among sentence. On the other hands, the learners who performed well in the pre-test gain a little since they have the skill. In details, the learners with good pre-test rating results mostly increase the outcome for keywording and overall-convincible, respectively.

Table 4. *Improvement Result based on Pre-test Rating*

Group	Rating score by pre-test				
	≤6	>6, ≤8	>8, ≤10	>10, ≤12	>12
1	1.00	1.50	-0.17	0.33	-0.89
2	2.17	1.60	1.22	0.67	0.33
3	5.67	5.22	4.73	1.67	0.78

After the experiments, learner participants were asked for opinions regarding the learning. Participants from Group2 and Group3 gave remarks that ‘they never know that reading articles could be used to learn for how to write’. They also mentioned that they can visualize the logical relations of sentences, and this results in understanding author’s aim of the article as well as context comprehensibility. With this understanding, they also are motivated to read more articles since it is easier to obtain knowledge than prior. For those participants from Group1, most of them revealed that they did not fully understand the thinking process of the author as well as their own cognitive process while reading and writing. They were clueless on what to be focused when reading and writing, and let their mind astray from objectives.

#### 4. Conclusion and Future Work

This paper proposes a thought analysis tool via reading. The tool, despite involving in reading, does not aim to support language learning or improve reading skill, but it is designed to help learners to draw out the thought of the article author by mapping the hidden logical relation of sentences in the writing pieces. Concept mapping by annotating type of statement to the sentences assists to reveal main concepts and a connection between sentences. By making the logical relation explicit, learners are trained and learned to think about what author do to convince readers as a strategy and the pattern used to express the statements. This is expected that by learning to think about other’s thinking learners are affected to improve their own cognitive process as to think about their thinking when they hold a role of writer.

From the experiment, the results signified that the thought analysis tool via reading improved users in terms of becoming more strategic planner and making a convincing writing piece. In comparison to other methods including lecturing and training without the tool, the improvement of the tool user group was clearly higher. Moreover, the results of improvement based on pre-test rating indicated that the tool works best for the groups of learners with the low cognitive skill proficiency while it showed less effectiveness to those with high pre-test rating.

To improve our work, we plan to apply the tool to train a thinking process on other subjects such as art designing, movie script writing, translating and researching. We also plan to visualize the annotated data of connected logical expression into a graph-based representation and study the found patterns. Furthermore, more experiments to different age-groups and knowledge background will be conducted for studying the effect of the thinking training and their improvement in metacognition.

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