# Thesis Abstract
## 論　文　の　要　旨

題　目　Thinking Process Analysis and Multiple-Languages Utilization in a Learning
　　　　Environment for Problem Posing as Sentence Integration
　　　　（単文統合型作問の学習環境における思考過程分析と複数言語での活用）

氏　名　NUR HASANAH (D134447)
　　　　Learning Engineering Laboratory, Graduate School of Engineering, Hiroshima University

Problem posing practice involves the generation of new problems in addition to solving pre-formulated problems. However, achieving practical implementation of learning by problem posing faces the issue of inefficiency due to the time needed for assessment and giving feedback to students' posed problems. Monsakun ("Problem-posing Boy") is a computer-based learning environment to realize learning by problem-posing in a practical way for one operation of addition and subtraction using sentence-integration. The integration process of solving arithmetic word problem involves processing the linguistic meaning into arithmetical formulas which are similar in any language.

The first aim of this thesis is to analyze the learning process in using Monsakun for learning problem-posing through sentence-integration. Previous studies have reported the evaluation of learning outcome using Monsakun in practical studies at Japanese elementary school through pre and posttests as well as questionnaires. As the system is designed to promote learners to think about constraints when posing problems, it is necessary to observe the learning process, as in whether learners' activity in posing problem follow our design, which in turn elucidates the learning outcome of Monsakun.

The second aim of this thesis is to utilize the Triplet-Structure Model in multiple languages as an initial research towards suggesting a universal sentence-integration method to learn problem-posing in arithmetic word problems. The Triplet-structure model is designed to describe the quantitative information in a word problem as a bridge between the linguistic and the numeric information in the problem. Solving a word problem involves an integration process, defined as the process of translating the linguistic meaning in a word problem into arithmetical formulas, which are similar in any language. Although the meaning of numbers is not represented in the numeric information expressed as equation, it is necessary to ensure the consistency between the linguistic and the numeric information, which is the role of the Triplet-structure model.

Based on the research goals, we defined the main research questions as follows: (1) Do learners pose problems in Monsakun with a consideration towards the sentence structure? (2) In what way the trends of posed problems by learners could be explained with the Triplet Structure Model? (3) How does Japanese adult pose problems in Monsakun compare to Japanese elementary school children? (4) Is Monsakun in languages other than Japanese acceptable to non-native Japanese speakers?

The study started by analysis of the log data of university students to understand students' thinking process while posing arithmetical word problems. We focused on the first sentence card selected in the process of posing a problem and investigated whether learner's selection changed through the exercise. From the analysis, we found that

the proportion of first sentence selected in each assignment were different in several ways, and the proportion of each sentence card to be selected firstly is not even. Depending on the type of story and subjects' exercise experience, they applied different approach of first card selection. From this change of approach, we infer that learners who used Monsakun were able to recognize the difference problem structure in Monsakun. The recognition of the difference is important for learners to understand the nature of arithmetic word problems. This study served as a precedent of the next study regarding the log data from the practical use in an actual classroom.

In the next study, we investigated problems posed by elementary school students to gather whether Monsakun encourages them to think about the structure of arithmetic word problems. The study was conducted by testing the randomness of learners' answers and analyzes the change of tendency in the posed problems. From the analysis of satisfied constraints in frequent errors, we found that first grade students understand several constraints better than the others. From the results, it can be inferred that the learners are aware of the structure and constraints of arithmetic word problems (either completely or incompletely) and try to satisfy the constraints in posing word problems with Monsakun.

In the second half of this study, we investigated whether Triplet Structure Model depends on Japanese language. We analyzed the use of Monsakun in English or Indonesian by non-native Japanese adults and compared it with the use of Japanese children and adults. We also reported the satisfied constraints and the acceptance of Monsakun through a questionnaire. It was observed that the difficulty experienced by the learners are similar. The analysis result shows that compared to Japanese, there is no significant difference in the process of problem-posing with Monsakun in English or Indonesian. The tendency when posing problems, that is to satisfy constraints as many as possible, were found in both Japanese children and adults, as well as in English and Indonesian learners.

As a follow up of the previous study, we conducted an experimental use of Monsakun for Indonesian elementary school students living in Japan. We introduced them to problem-posing through sentence-integration and analyzed their learning activities in Monsakun. The students performed well in the extraneous problem test. Using Monsakun, they were able to pose a lot of word problems compared to traditional problem-posing method. The average steps and mistakes shows increasing rate from Level 1 to Level 5, a trend which was also observed in previous practical use of Monsakun by Japanese elementary school students. The questionnaire result shows that even though they thought it's relatively not easy to pose problems, all students enjoyed posing problems with Monsakun.

Through a series of study, we have focused on the overall trends of learners' product of problem posing through analytical methods. The result of product analysis shows a trend that learners try to satisfy problem constraints in the posed problems. In addition, based on the results of data analysis and questionnaire, it is suggested that the Triplet Structure-Model is acceptable in multiple languages. The use of Monsakun provides a way of creating an interactive and fun environment for learning by problem posing for Indonesian elementary school students.