The Effect of Logical Argument Recomposition using Triangular Logic Model on Critical Thinking Skill Compared to Conventional Method

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Declaration of Authorship

I, Hori Jawad Rashid (M210650), declare that this thesis titled, "The Effect of Logical Argument Recomposition using Triangular Logic Model on Critical Thinking Skill Compared to Conventional Method" and the work presented in it are my own. I confirm that:

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- Where I have consulted the published work of others, this is always clearly attributed.
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Abstract

Critical thinking is a valuable skill to have in today's fast-paced and complex world. It helps individuals to think independently and to make informed decisions that are grounded in evidence and logic. Critical thinking consists of five mutual skills which are analyzing arguments, assumptions, deductions, inference, and interpreting information. The incorporation of technology-based approaches and exercises in critical thinking instruction can enhance the process of critical thinking by providing new ways of interacting with and analyzing information, as well as by allowing the development of more personalized and effective instruction that addresses the unique needs of different learners. Additionally, it is important to externalize the process of critical thinking in order to facilitate the understanding and improvement of the learners' abilities, as well as to allow practitioners to gain insight into the impact of specific exercises on critical thinking skills. The purpose of this study was to examine the effectiveness of a logical argument recomposition approach, referred to as the Triangular Logic Model (TLM), in enhancing critical thinking skills compared to the conventional method, and to investigate the impact of TLM exercise on each component of critical thinking. The study employed a pre-test/post-test quasi-experimental design with experimental group and control group. The participants were undergraduate students at an Indonesian university. The experimental group performed Triangular Logic Model (TLM) exercise while the control group engaged in conventional critical thinking problems. Both groups were evaluated using the Watson Glaser Critical Thinking Appraisal (WGCTA) to measure the effectiveness of the treatments in enhancing critical thinking skills. The results indicated that: 1) TLM exercise possibly has a positive effect on improving the skill of critical thinking; 2) TLM exercise has an influence on three of the five critical thinking categories of WGCTA. 3) Students give a strong agreement in their opinion on using TLM-based exercise as a tool to improve their critical thinking skills. This study suggests that the TLM exercise could be a promising method for enhancing critical thinking skills in undergraduate students.

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List of Publications

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Chapter 1

Introduction

Human beings possess a range of skills that are considered essential for personal and professional development. Among these skills is critical thinking. The present study focuses on critical thinking skills and introduces a recomposition exercise approach to improve this skill.

Critical thinking is a cognitive process that involves the systematic analysis and evaluation of information from various sources in order to make informed decisions and reach sound conclusions based on evidence. It requires the active and skilled utilization of observation, experience, reflection, reasoning, and communication (Eggen & Kauchak, 2011; Scriven et al., 1987). Critical thinking is important as it allows individuals to analyze information objectively and make informed decisions. It is essential in various aspects of life such as education, the workplace, and personal decision-making. Additionally, it helps to foster creativity, open-mindedness, and flexibility of thought (Johanson, 2010; Wallace & Jefferson, 2015). Studies have also shown that critical thinking skills are positively related to academic performance and job performance. It can also improve decision-making abilities. Furthermore, critical thinking plays a crucial role in personal and professional development by allowing individuals to evaluate and understand the thought processes of others.(Facione et al., 2011; Gambrill, 2012; Halpern, 1998) It is essential to note that simply having access to a vast amount of information does not necessarily translate to an individual's ability to think critically. This is particularly relevant in the field of education where the acquisition of knowledge alone is not sufficient. Being able to rationally analyze, evaluate, and draw conclusions from the information gathered is an essential element (Huitt, 1998).

Critical thinking can be described as a collection of five components namely: analyzing arguments, assumptions, deductions, inferences, and interpreting information (G. Watson, 2006; G. B. Watson & Glaser, 1994). The development of new approaches and exercises that take advantage of technology can help to improve critical thinking skills in this digital age. It is particularly important to externalize the process of critical thinking to support the process for the learners as well as to let the practitioners understand how a particular exercise affects these components of critical thinking.

The objective of this study is to investigate the effect of using the Triangular Logic Model (TLM) recomposition exercise on students' critical thinking. Additionally, providing a more detailed understanding of the specific components of critical thinking skills in which the TLM exercise may have the greatest impact since each component is a different cognitive process that is used in critical thinking. Necessarily, the study also assesses the usefulness of the TLM activity and students' attitude towards it compared to traditional methods. By assessing the students' impression of using the TLM method, the study will provide valuable feedback on the usability and acceptability of the TLM exercise as a critical thinking exercise. The ultimate goal of this study is to provide insights into using TLM as a tool for developing critical thinking skills as a new digital approach and to contribute to the growing body of literature on critical thinking topics.

These findings will have practical implications for the design and implementation of technology-based critical thinking exercises in education and training programs. Additionally, this study has the potential to contribute to the field of critical thinking research and education, it will contribute to the growing body of research on the use of technology in education, by providing new and innovative ways to engage students in practicing critical thinking skills.

The theoretical framework for this study is based on the Triangular Logic Model (TLM), which is a computer-assisted model designed as a logical reasoning exercise. In TLM, a logical argument is broken down into three-clause arguments that are data (ground), warrant (reason), and claim (conclusion) based on Toulmin Model (Kneupper, 1978). The components are then given to the learner to recompose it back to the original logical arguments by specifying the type of each piece of the argument according to the Toulmin Model. According to Hirashima (2021) this kind of logical recomposition helps identify the construction of logical arguments and promotes the understanding of others' arguments; thus possibly promoting critical thinking. It is because the ability to think critically requires understanding others' arguments so that

one can follow the thought process of others and understand the reasons why they reach a specific conclusion. The TLM is designed to improve critical thinking skills by providing learners with logical propositions, or "premises" which they use to reach a logical conclusion. The TLM is computerized, which allows for tracking of the learning process and personalized diagnostic feedback. This trial-and-error approach is believed to improve learner confidence, motivation, and attainment (Kitamura et al., 2015).

The study employs an experimental research design, utilizing a split-sample method where participants are divided into a group receiving the TLM exercise (experimental group) and a group receiving a narrative-based exercise (control group) to compare the effectiveness of the two methods in improving critical thinking skills. To achieve the objectives of this research, a preliminary experiment was conducted to address the following research questions:

1. What is the effect of using TLM recomposition exercise on learner's critical thinking ability compared to the conventional method.
2. What is the effect of TLM recomposition exercise on each of the five components of critical thinking skill.
3. What is the students' impression of using the TLM recomposition method as a critical thinking exercise in terms of usefulness and attitude compared to the conventional method.

The aim of the preliminary experiment is to examine the practical use of the developed tool according to the proposed exercise and investigate the expected influence of it on critical thinking skill and its' components.

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Chapter 2

Background

2.1 Triangular Logic Model (TLM)

Graphical representation is believed to enhance learning better compared to natural language representations (Fan, 2015). Triangular Logic Model (TLM) is a computer-assisted online model, designed and developed as a logical reasoning exercise. TLM creates a graphical representation coupled with textual information of a logical argument. The use of both linguistic and visual information together offers double support for both learning and the acquisition of knowledge (Vavra et al., 2011). The model has been previously confirmed to be usable and effective for improving logical thinking ability when used in a Japanese environment (Kitamura et al., 2017). TLM as shown in Fig. 2.1 is composed of three-clause logical argument based on three main components of Toulmin model which are data (ground), warrant (reason) and claim (conclusion) as three corners of a triangle.

On the left-side of the user interface, cards are provided where each card represents a premise. on the right-side, a triangle representing the three components of logical argument is created based on the Toulmin model. The exercise asks the learner to identify the correct premises by connecting them to the correct side of the triangle. This process is called recomposition from given components. Recomposition has been used in concept maps and proven to enhance learning similar and even better in some aspects compared to drawing from scratch (Hirashima, 2019). During the recomposition, it is believed that interpretation, analysis, inference, evaluation, and/or recognition might happen. These are the essential elements of critical thinking. The logical propositions, which for simplicity we call them cards, provided by the teacher are extracted from a logical argument. The learner has to utilize

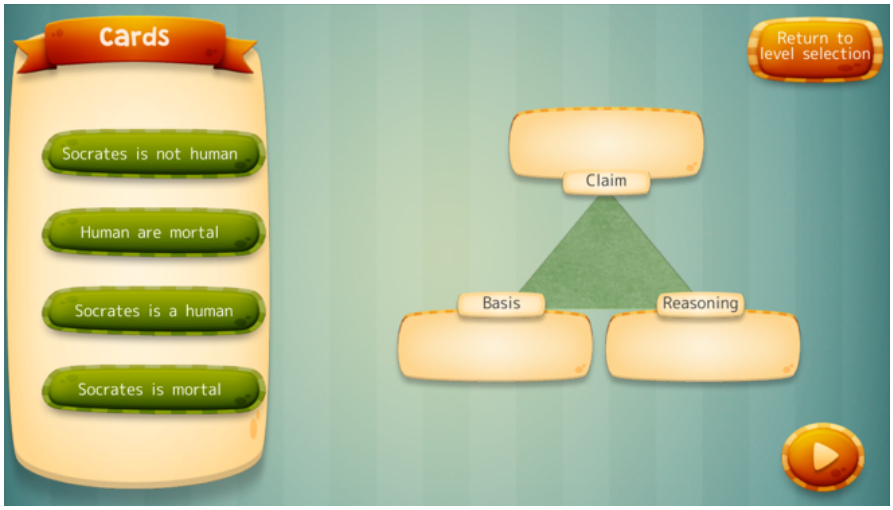

Fig. 2.1 TLM User Interface.

his skills to reach the appropriate logical conclusion using the given information(cards or logical propositions). This activity contains various levels of different designs and difficulties. In some levels there provided dummy cards along with the necessary cards to increase the challenge. Other variations include, originally placing one of the cards in its correct position on the triangle and requiring to complete the remaining parts. Moreover, TLM is well-organised with an attractive interface. The users have the opportunity to treat it like a game to enjoy while learning.

TLM is totally computerized approach which makes it different from conventional methods of practicing logical reasoning exercises. The advantage of this method is easy application and control of the exercise by the teacher in an educational setting such as school or university. Additionally, ability to record and keep track of learner behavior during the argument recomposition, which allows the educator to investigate the details and enhance the activity accordingly. Another powerful feature of the TLM exercise which is provided for supporting the learning process is the diagnostic feedback. The diagnostic feedback corresponds to the mistakes of each student, making it relevant and customized. It informs learners of their strengths and weaknesses, as well as areas for progress.

2.2 Watson Glaser Critical Thinking Appraisal (WGCTA)

Watson Glaser Critical Thinking Appraisal (WGCTA) is a widely utilized and validated measure of critical thinking abilities (Bernard et al., 2008; Hassan & Madhum, 2007). Developed by G. B. Watson and Glaser (1994), the WGCTA is a verbal task consisting of 40 exercises that assess an individual's ability to engage in critical thinking. The WGCTA has been used in both academic and professional settings as a means of evaluating an individual's ability to reason, make inferences, evaluate arguments, and identify assumptions. The WGCTA is used to predict success in nursing programs as it is said to have a strong correlation with students' GPA (Crouch et al., 2015). The test is also used in educational research to evaluate the effectiveness of critical thinking instruction and to identify areas of improvement for students (Drennan, 2010).

The WGCTA consists of multiple-choice questions divided into five sections: inference, recognition of assumptions, deduction, interpretation, and evaluation of arguments. Each section is designed to measure a corresponding aspect of critical thinking, and the test as a whole is intended to provide a comprehensive assessment of an individual's critical thinking abilities (Loo & Thorpe, 1999). *Inference* measures the ability to draw logical conclusions from given information. *Recognition of Assumptions* measures the ability to identify unstated assumptions in given arguments. *Deduction* section measures the ability to evaluate the logical consequences of given information. *Interpreting Information* measures the ability to interpret and understand the meaning of given information. *Analyzing Arguments* measures the ability to evaluate the strength and weaknesses of given arguments.

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Chapter 3

Method

This study aimed to investigate three key research questions. The experimental design was carefully and thoroughly planned, with multiple revisions and adjustments made in light of the research questions. A pilot study was conducted beforehand to ensure the success of the study. The pilot study served as a test of the feasibility of the research design and methods and allowed for the identification and resolution of any potential issues or problems. Additionally, the pilot study provided an opportunity to further refine the experimental design and make any necessary adjustments before proceeding with the main study, to ensure the validity and reliability of the research findings.

The participants were divided into two groups experimental and control. The experiment proceeded likewise for both groups. The only difference was that the experimental group subjects were given the TLM exercise to practice critical thinking while the control group subjects were given a narrative-based exercise as in the conventional method. The form of the exercise of the control group is similar to the form of WGCTA used in the assessment where both are narrative based. Whereas the TLM exercise is card-based recompositional method. In addition to the pre-test and post-test, at the end of the second session, the subjects from both groups were required to answer multiple questionnaires. An attitude and usefulness questionnaire on a 7 Likert-type scale (strongly disagree to Strongly agree) questionnaire. Another questionnaire to measure the perceived difficulty of the English language of the exercises as English was not their native language. The English language questionnaire was on a 5 Likert-type scale (Very difficult, Difficult, So so, Easy, and Very Easy).

3.1 Participants

Participants were first-year undergraduate students enrolled in a basic programming class from the informatics department of Yarsi university in Indonesia. Choosing such a class of participants, we made sure that the subjects have similar levels of Pre-existing knowledge as our experiment involves testing the effectiveness of a particular learning method which is TLM. Undergraduate students are said to be undergoing rapid development of their CT skills Denney (1995); Friend and Zubek (1958); Lehman and Nisbett (1990). The number of participants was ten; divided into two groups of 5 experimental and 5 control, based on their grade point average - GPA. Informed consent was obtained from all participants prior to their participation in the study. This included providing them with detailed information about the purpose, procedures and any potential risks or benefits associated with the experiment.

For the next experiment, it is important to have a large enough sample size to detect more specific effects. A larger sample size can increase the power of this study, although it may require more time and resources to recruit and test participants.

3.2 Materials

Fundamentally, the topic for both groups' exercise was based on logical reasoning. For the experimental group, the material was provided in the form of TLM exercise to be practiced in two sessions. As for the control group, a narrative-based exercise was prepared according to the conventional method used to prepare for critical thinking exam preparation. Both materials were reviewed and approved by the main class teacher and the assistant teacher. The first session of the TLM exercise was composed of a total of 40 questions divided into five levels of difficulty; eight questions each. The second session TLM recomposition exercise similarly contained 40 items divided into five levels of difficulty; eight questions each but more challenging compared to items in the first session. On the other side, the material for the control group was provided in a conventional way of multiple choice questions. Each question was a narrative about a case and the learner was requested to choose the best choice based on the narrative. The number of questions and the given time for each session was exactly the same as the experimental group. It should be mentioned that similar to the experimental group, the exercise difficulty for the second session was more challenging for the control group too.

To measure the CT after the treatment, both groups answered a CT test (Sample Watson Glaser Critical Thinking Appraisal | AssessmentDay) *Sample Watson Glaser Critical Thinking Appraisal | AssessmentDay* (2022). This test prepared by professionals to precisely follow the original Watson Glaser Critical Thinking Appraisal (WCCTA) Form S G. Watson (2006); G. B. Watson and Glaser (1994) consisting of five categories of CT skills: analyzing arguments, assumptions, deductions, inferences, interpreting information. The test consists of forty multiple-choice questions, 8 questions per each category.

3.3 Procedure

Fig. 3.1 shows the experiment flow, duration, and tasks during each session. Firstly, both groups were given instructions and informed about the policies of the experiment. Following that two training examples were demonstrated for each group separately. It took about 15 minutes to present the instructions and the training. Next, both groups did the Watson Glaser Critical Thinking Appraisal (WGCTA) test to measure their skill of critical thinking. The pretest took 50 minutes to answer 40 questions. Following the pretest, the experimental group participants were given the TLM exercise to practice which also took 50 minutes. Simultaneously, the control group was given the exercise in the conventional method. After nearly a period of two hours first session was completed.

The study's duration was chosen to be appropriate for observing changes in critical thinking skills (Kaya et al., 2017). Research indicates that critical thinking skills require time to develop, thus the study was conducted over two sessions to allow for these changes to occur.

The second session started the next day, providing the experimental group with the next five levels of the TLM exercise holding a total of 40 problems to be completed within 50 minutes. At the same time, the control group was given the next 40 exercise items to be practiced within the period of 50 minutes. Following that practice period, both groups were given WGCTA posttest for measuring their skill of critical thinking after two sessions of logical reasoning exercises. At the end of the second session, both groups were required to complete a TAM questionnaire and then two questions about the difficulty level of the logic of the exercises and the English language taking a period of 15 minutes.

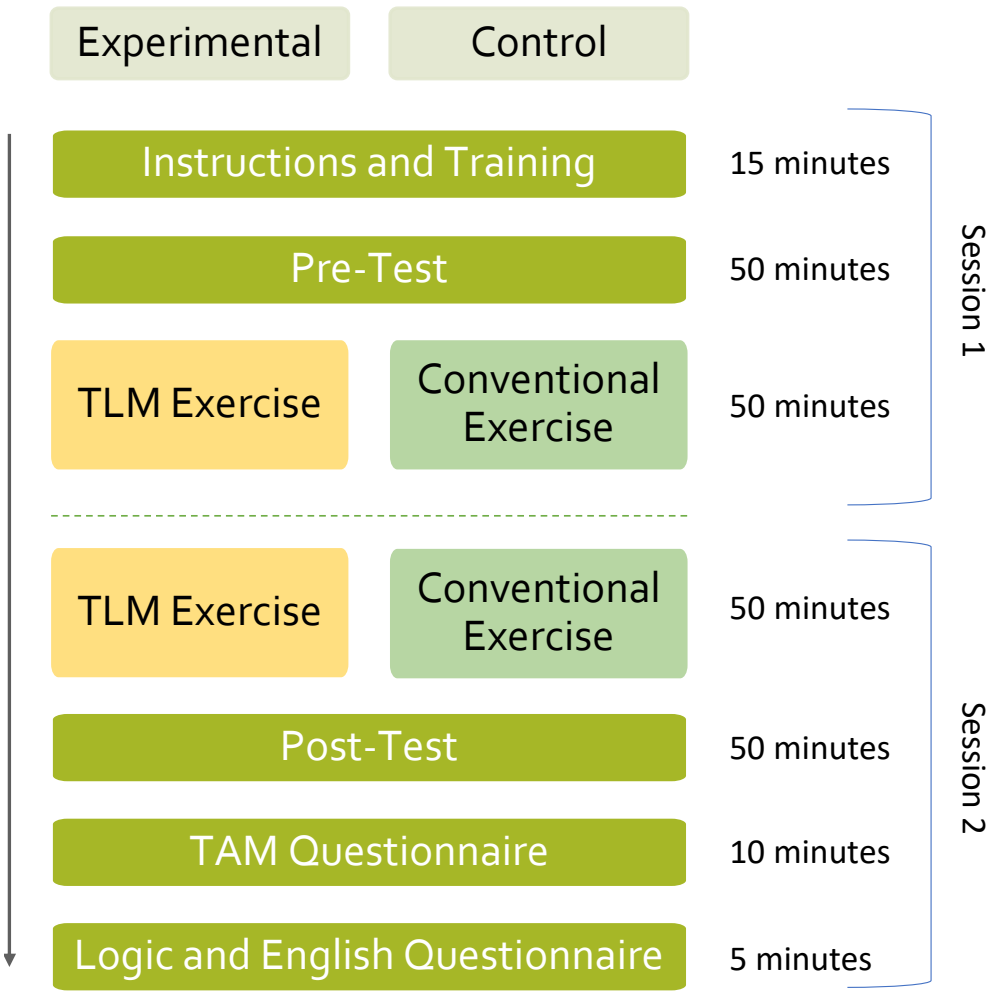

Fig. 3.1 Experiment Flow.

Chapter 4

Analysis and Results

Although the experiment consisted of ten participants, one of the experimental group subjects could not make it to the second session of the experiment thus the data is excluded.

The results of questionnaire about the difficulty of the assessment in terms of language shown in Figure 4.1. It can be seen that 78% of the participants perceived the language as easy and 22% as fair. It interprets as that the students did not face difficulty in dealing with the questions in English language.

Due to the small number of participants per group, we could not run a reliable statistical analysis on the scores of critical thinking measurements. However, we try to show the raw scores of the test results and the learning gain with the aim of confirming the practicability of the TLM method and the validity of the conventional method.

4.1 Triangular Logic Model and Critical Thinking

Table 4.1 shows the descriptive analysis of the pre/post test for both groups and the line chart in Fig.4.2 shows the relationship between the means of pre-test and post-test of both experimental and control groups. To show the actual learning gain we have calculated the *normalized change* score for both groups. In analyzing the normalized change score, academic achievement is measured in terms of its maximum potential for improvement or decline thus avoiding the bias in pre-test score Marx and Cummings (2007); Setiawan and Kudus (2020). As expected, the Anova test did not reveal any differences mostly because of the small number of participants. However, the increase

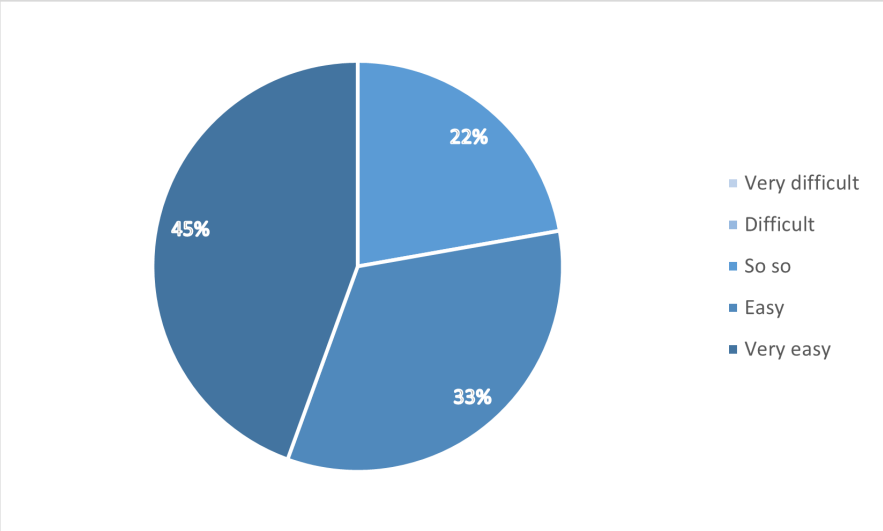

Fig. 4.1 English difficulty questionnaire result.

in the learning gain of both groups can be an indicator of the similarity of TLM method effectiveness to the conventional narrative method. Although the control group material is prepared in a way similar to the WGCTA test format, that is, it performs as a training for the test. Based on the average scores of the tests, we can observe that the TLM exercise possibly can be as effective as the conventional method to improve the learner's critical thinking skill.

The scatter plot in Fig. 4.3 shows how each individual performed during the pre-test and post-test for both groups. Categorizing the learners into improved and not-improved, two learners in the experiment group and two learners of the control group were able to get higher scores in the post-test. Nevertheless, the improvement of the experimental group learners is higher than those of the control group. This interpretation can possibly show that although the mean of the control group is higher than the experimental group, the improved learners of the experimental group achieve higher learning.

Moreover, TLM has the potential to support learners by monitoring the thinking process and personalizing feedback according to the level of the learner. That is in TLM, the learner has the opportunity to think and try, then see his error, evaluate, learn from it, synthesize and recompose repeatedly up to learning and getting to the correct logical argument. This process repeats for every single item which eventually trains the learner to improve and recognize the fundamental parts of logical argument which is necessary for critical thinking. A large-scale experiment is crucial to further investigate

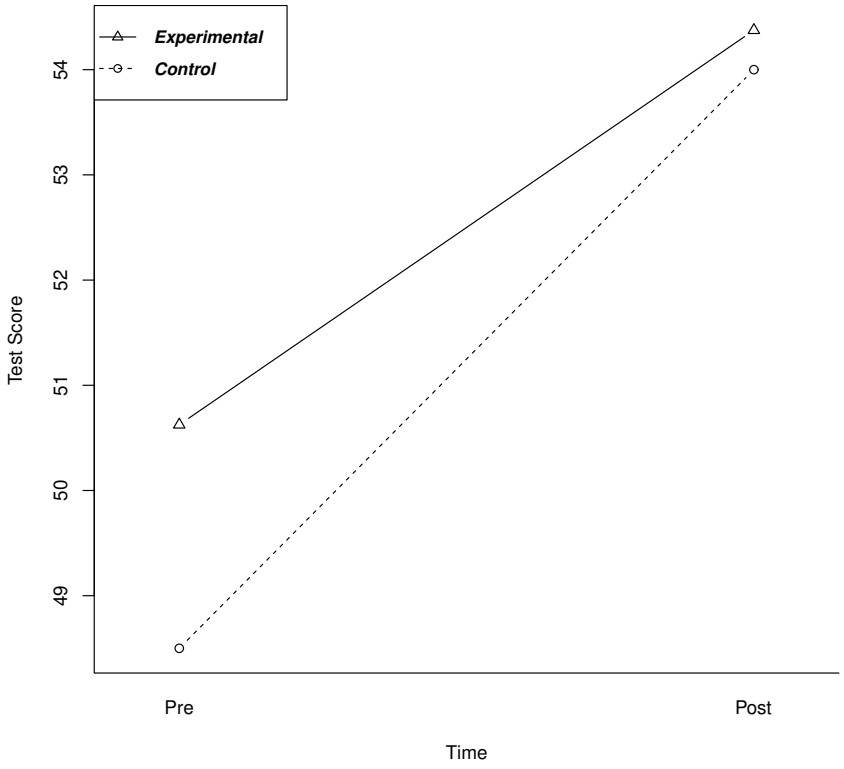

Fig. 4.2 Average Critical Thinking Score for Groups.

the effect of TLM and to analyze learner behavior during the recomposition task.

4.2 Triangular Logic Model and categories of critical thinking

As it is mentioned in the previous sections of this study, the critical thinking test used comprises five categories of Analysing arguments, Assumptions, Deductions, Inferences, and Interpreting Information. The second research question aimed to examine the effect of the TLM exercise on each category of critical thinking. Therefore, we have calculated the normalized change for each category of the critical thinking skill test. From the descriptive analysis as shown in Table 4.2 we can observe an increase in the post-test score in each of Analysing arguments, assumptions, and deductions categories for TLM group.

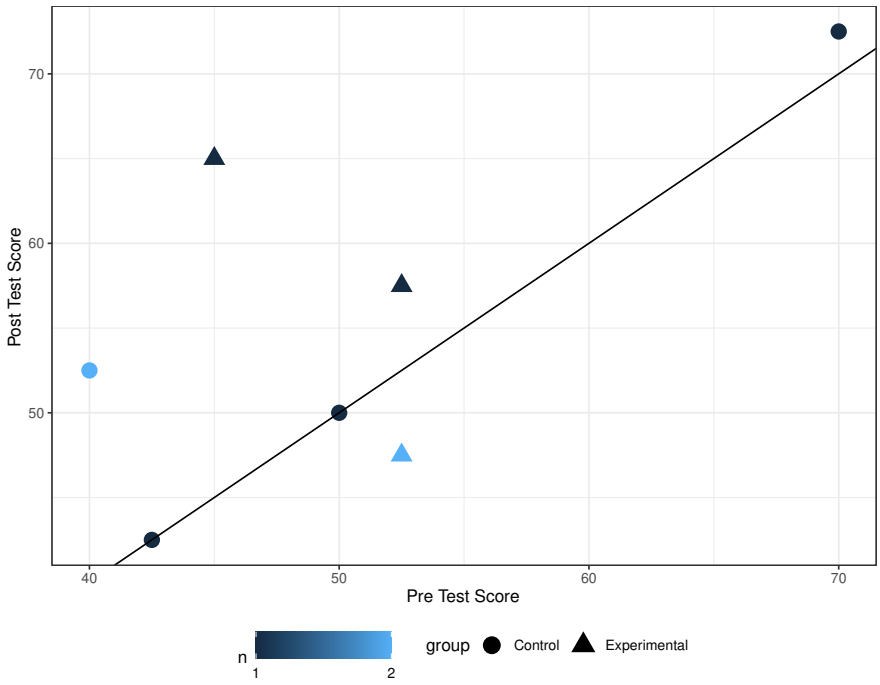

Fig. 4.3 Scatter plot showing the critical thinking scores for both groups during pre-test and post-test

Comparing their learning gain to the control group, TLM group has improved better mainly in analyzing arguments and deduction while not showing much difference in Interpreting information. One the other hand, control group shows higher learning gain in assumptions and inferences. Analyzing arguments in its definition is examining and evaluating the logic and structure that the author utilizes to illustrate their argument. The TLM is designed in a way that the learner repeatedly scrutinizes the provided argument statements and tries to recompose the arguments by doing logical reasoning to draw a conclusion. This category of critical thinking and TLM make a strong match in the definition and the practical results which indicate that the TLM has a direct effect on improving this category of critical thinking. Similarly, assumption questions require the learner to decide on a given information should certain conclusions be made. Such skill is highly influenced by recognizing the parts of logical argument clauses and differentiating between valid and not valid premises. In TLM the learner is given extra cards which contain invalid premises thus pushing the learner to recognize the pitfalls in an argument.

The remaining three categories could not be improved with TLM can hold two explanations; one, a larger test sample is necessary to create the differ-

Table 4.1 Mean and standard deviation of the critical thinking test.

	N	Pre		Post		Norm. change
		Mean	SD	Mean	SD	
Experiment	4	50.63	3.75	54.38	8.51	0.07
Control	5	48.50	12.70	54.00	11.12	0.1

Table 4.2 Mean and Standard Deviation of Critical Thinking Categories.

WGCTA Category	Group	N	Pre		Post		Norm. Change
			Mean	SD	Mean	SD	
Analyzing Arguments	Exp	4	65.63	1.26	78.13	0.96	0.32
	Control	5	67.50	2.31	65.00	1.63	0.02
Assumptions	Exp	4	59.38	0.50	62.50	0.82	0.1
	Control	5	56.25	0.50	67.50	1.50	0.4
Deductions	Exp	4	56.25	0.58	62.50	1.83	0.18
	Control	5	52.50	0.96	50.00	0.50	0.02
Inferences	Exp	4	18.75	1.29	15.63	1.50	-0.33
	Control	5	12.50	0.50	22.50	0.58	0.12
Interpreting Information	Exp	4	53.13	2.50	53.13	0.50	0
	Control	5	55.00	2.00	65.00	0.50	0.1

ence; two, the TLM exercise lacks practice for the needed that influences these three categories. Overall, the analysis is possibly indicating the connection between TLM and sub-categories of critical thinking. In future research, we try to investigate the reliability of such relationships and pinpoint the necessary practice for each category.

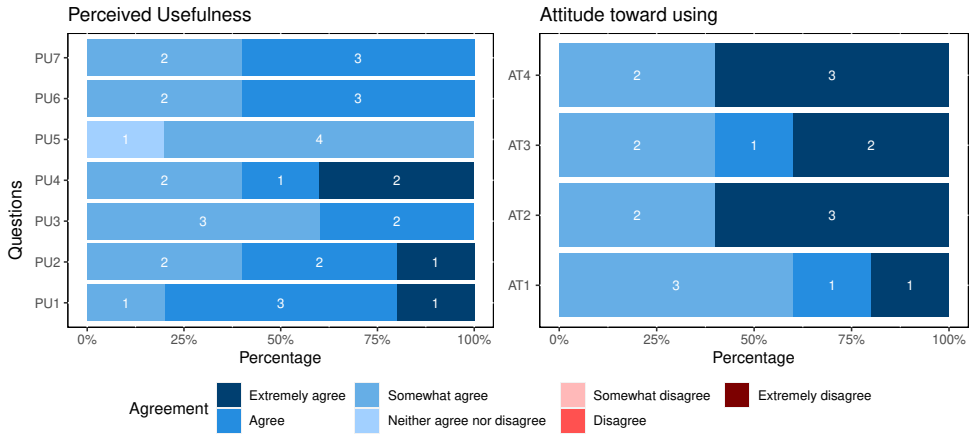

Fig. 4.4 Experimental group questionnaire result for perceived usefulness and attitude towards using the TLM as a critical thinking exercise

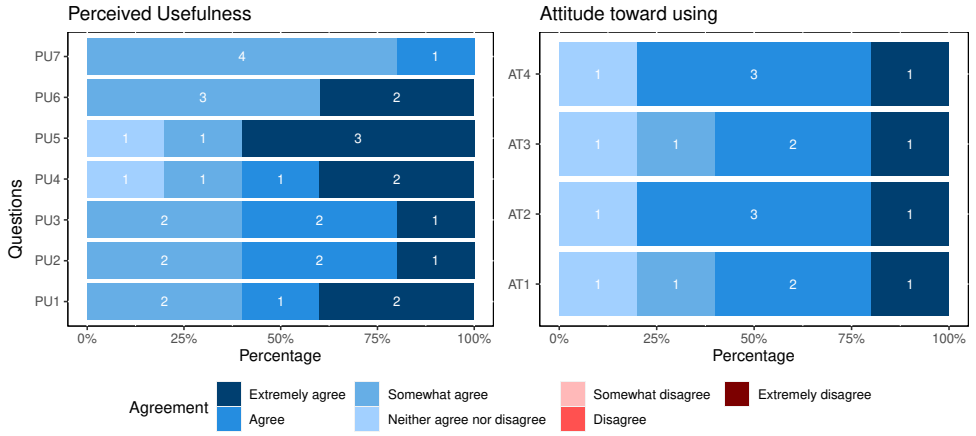

Fig. 4.5 Control group questionnaire result for perceived usefulness and attitude towards using the TLM as a critical thinking exercise

4.3 TLM and Impression of the learners

To answer the third research question, we have analyzed the questionnaire results for "perceived usefulness" and "attitude toward using" for both experimental and control groups. Fig. 4.4 and 4.5 shows the percentage stacked bar chart for experimental group and control group respectively. In both groups all learners hold a very positive impression where most learners agree or extremely agree to the usefulness of their used method in improving their critical thinking skills. The same goes for their willingness in using their method as a practice to improve their skills of critical thinking. In spite of that, comparing both groups reveal interesting differences of the learners between the groups.

As for the perceived usefulness, conventional method learners which used a narrative-based exercise hold a stronger agreement about 50 percent while such extreme agreement is less than 25 percent in the experimental group. This indicates that the material that is used in the conventional method is believed to be highly useful and the narrative method seems to create better confidence within learners. In TLM, the extremes are fewer probably because of the uniqueness of the exercise compared to the conventional method. Looking at the attitude toward using the treatment method, we notice an opposite percentage for each group compared to the usefulness. Almost 50 percent of the learners of the experiment group show a strong agreement in their attitude toward using TLM as an exercise while only 25 percent hold such strong agreement in the control group.

Chapter 5

Conclusion

The preliminary results of the pilot study indicated the practicability of utilizing TLM-based exercises for the improvement of critical thinking skills and showed a positive effect of using the TLM-based exercise on learners' critical thinking ability. The results also show that the Triangular Logic Model (TLM) recomposition exercise was effective in enhancing critical thinking skills, particularly in the CT components of analyzing arguments, recognition of assumptions, and deduction.

According to the results, the TLM exercise has similar effects to the conventional method exercise which is commonly used as a preparation for critical thinking tests. TLM results also outperform the conventional method in two categories, even though, unlike the conventional exercise, TLM has a different form from the CT test.

These findings suggest that TLM is a promising approach for promoting logical thinking as the base of critical thinking. At last but not least, questionnaire analysis revealed that learners are strongly willing to use TLM exercise for their self-study more than using the narrative method when it comes to critical thinking practice. The learners also believe in the usefulness of the TLM method to be very similar to the common narrative method.

In collaboration with an Indonesian university, we already designed and planned to conduct a wide-scale experiment where a large number of undergraduate students will be recruited. The purpose is to collect more reliable data that allows stronger statistical analysis. We aim to look deeper into the effects of TLM recomposition exercise on critical thinking and the components of critical thinking to answer the following research questions: 1) Can we detect a significant improvement in the critical thinking skills of the learners for the TLM method? 2) What will be the correlation between the scores

of the TLM exercise and the learning gain of critical thinking? 3) How TLM affects each category of critical thinking skills and how this effect can be extended?

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Appendices

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Appendix A

A Sample of WGCTA Assessment Questions from Assessmentday

A.1 Analyzing Arguments

In this section, a statement is presented to you with an agreeing or disagreeing argument below. You must regard each argument as true, regardless of whether it is weak or strong, agrees or disagrees with the statement. If you consider an argument to be strong, select Strong argument, or if you consider an argument to be weak, select Weak argument. Judge each question and argument individually. Try not to take into account individual opinion or general knowledge since each argument is considered to be true.

Statement: Should university-level education be free to all students?

Argument One: No, too much education can lead to over-qualification, and therefore unemployment.

- Strong argument
- Weak argument (correct)

Argument Two: Yes, having a highly qualified workforce ensures high levels of employee productivity in organizations.

- Strong argument (correct)
- Weak argument

Argument Three: No, research has shown that students that are not required to pay tuition fees tend to slack off more and learn less during their degree.

- Strong argument (correct)
- Weak argument

A.2 Assumptions

In this section, you will be provided with a number of statements. Each statement will be followed by a series of proposed assumptions. You must decide which assumptions are logically justified based on the evidence in the statement. If you think that the assumption is taken for granted in the statement, and is therefore logically justified, select Assumption made. If you think that the assumption is not taken for granted in the statement, and is not therefore logically justified, select Assumption not made. Remember to judge each question individually and base your responses on the statements provided.

Statement: In 2008, the President of the USA promised to prevent the country entering economic depression, but he failed because at the beginning of 2012, over 12 million USA citizens were unemployed.

Assumption 1: Unemployment is an indicator of economic depression.

- Assumption Made (correct)
- Assumption Not Made

Assumption 2: The number of USA citizens out of work ought to be less than 12 million.

- Assumption Made (correct)
- Assumption Not Made

Assumption 3: Presidents should stick to their promises.

- Assumption Made
- Assumption Not Made (correct)

A.3 Deductions

In this section, a statement will be provided followed by a series of suggested conclusions. Here, you must take the statement to be true. After reading each

conclusion underneath the statement, you must decide whether you think it follows from the statement provided. If you agree that the conclusion follows the statement, choose CONCLUSION FOLLOWS. However, if you do not agree that the conclusion follows then choose CONCLUSION DOES NOT FOLLOW You must select your answer based only on the information presented; not using general knowledge. Similarly, you are advised not to let your own opinions or prejudices influence your decisions; stick to the statements and base your judgments on the facts presented.

Statement In an attempt to cut expenses, an organization disbanded its IT department and outsourced its IT function to a business process outsourcing company. In doing so the company has managed to save 20% on its IT function expenditure.

Conclusion One: Outsourcing functions to business process outsourcing companies will cut expenses.

- Conclusion Follows
- Conclusion Does Not Follow (Correct)

Conclusion Two: The aim of this company's outsourcing was to make the organization more profitable.

- Conclusion Follows
- Conclusion Does Not Follow (Correct)

Conclusion Three: The outsourced IT function has saved the organization 1/5th on their IT function expenditure compared to the in-house IT function.

- Conclusion Follows (Correct)
- Conclusion Does Not Follow

A.4 Inferences

The questions in this section of the test will begin with a statement of facts that must be regarded as true. After each statement, you will be presented with possible inferences which might be drawn from facts in the statement. Analyze each inference separately and decide on its degree of truth.

For each inference, you will be provided with 5 possible answers: True, Probably True, More Information Required, Probably False, and False.

Select:

True, if you believe the inference is definitely true, i.e. it correctly follows beyond a reasonable doubt.

Probably True, if, based on the facts at hand, you think the inference is probably true; that it is more likely to be true than false, but not true beyond a reasonable doubt.

More Information Required, if you decide that there is not enough data to make a decision based on the provided facts (or lack of facts).

Probably False, if, based on the facts presented, you think the inference is probably false; i.e. it is more likely to be false than true, but there is not enough evidence to suggest that it is definitely false.

False, if you think the inference is definitely false; i.e. it must be incorrect because it misrepresents the facts provided or contradicts the facts provided in the statement.

Statement Although it is agreed that China is rapidly modernising its army, there is some doubt surrounding the exact amount it is spending. The research institute 'PIPPI', submits that the annual Chinese defence spending has risen from almost $31 billion in 2000 to over $120 billion in 2010. This figure is almost double the official figure published by the Chinese government, who fail to include many other areas, such as research and development in the official figure each year. In 2010, the United States government spent around $400 billion on military defence. Based on the current level of military growth, statistics suggest that China's defence spending could overtake America's by 2030. In addition to military spending, China's army continues to enjoy the largest number of people within the ranks of its army than any other country.

Inference 1: The official figures published by the Chinese government in relation to their military spending are thought to be misleading.

- True (Correct)
- Probably True
- Insufficient Data
- Probably False

- False

Inference 2: The Chinese government omits several key areas from its official spending figures, in areas such as military spending, agriculture, human rights and law.

- True
- Probably True
- Insufficient Data (Correct)
- Probably False
- False

A.5 Interpreting Information

The following questions will consist of a passage of information, followed by a series of conclusions. You are instructed to assume all information in the passage is true. The task is to judge whether or not each of the proposed conclusions logically flows beyond a reasonable doubt from the information given in the paragraph.

If you think that a conclusion follows beyond a reasonable doubt (but perhaps not absolutely), select "Conclusion follows". If you think the conclusion does not follow beyond a reasonable doubt based on the facts given, select "Conclusion does not follow". Do not use general knowledge when answering, only use the information provided in the passage. Remember to judge each conclusion individually.

Statement The British National Library has the largest collection of publicly-owned books in the United Kingdom. Therefore:

Conclusion One: There might be a larger collection of books in the United Kingdom.

- Conclusion Follows (Correct)
- Conclusion Does Not Follow

Conclusion Two: There might be a larger collection of publicly-owned books in the United Kingdom.

- Conclusion Follows
- Conclusion Does Not Follow (Correct)

Conclusion Three: The British National Library is in the United Kingdom.

- Conclusion Follows (Correct)
- Conclusion Does Not Follow

Appendix B

An Example of Treatment Exercices for Experimental and Control Groups

B.1 Experimental Group Exercise

The exercises in this section contain three or more propositions in the shape of cards. You have to recompose the correct logical argument by identifying the correct *Basis*, *Reasoning*, and *Claim* from the given cards and placing them on the corresponding position on the triangle. The statements have to be taken true disregarding commonly known facts.

Figures B.1, B.2, and B.3 show three kinds of exercises in TLM.

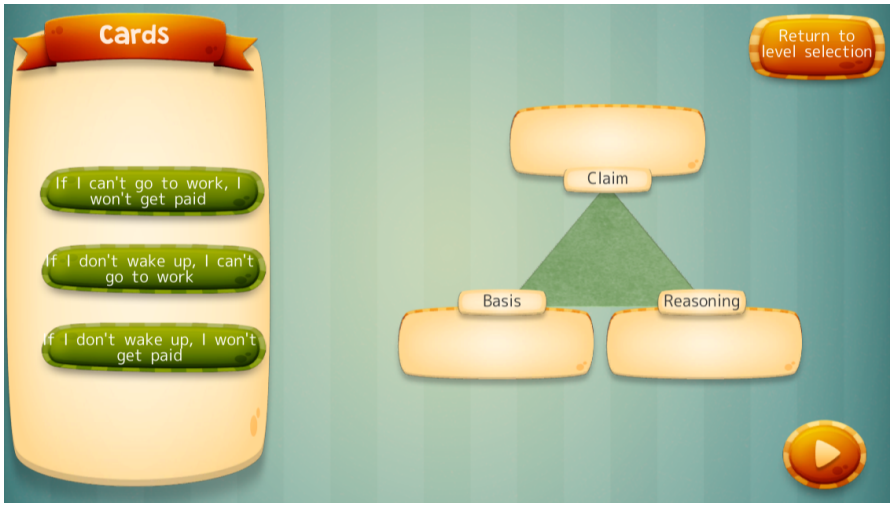

Fig. B.1 The correct answer is Basis: If I don't wake up I can't go to work, Reasoning: If I don't go to work I don't get paid, Claim: If I don't wake up I don't get paid.

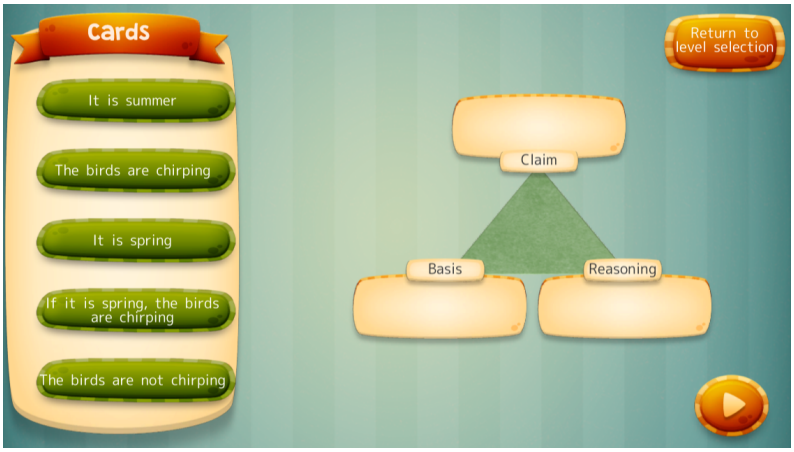

Fig. B.2 The correct answer is Basis: If it is spring the birds are chirping, Reasoning: It is Spring, Claim: The birds are chirping.

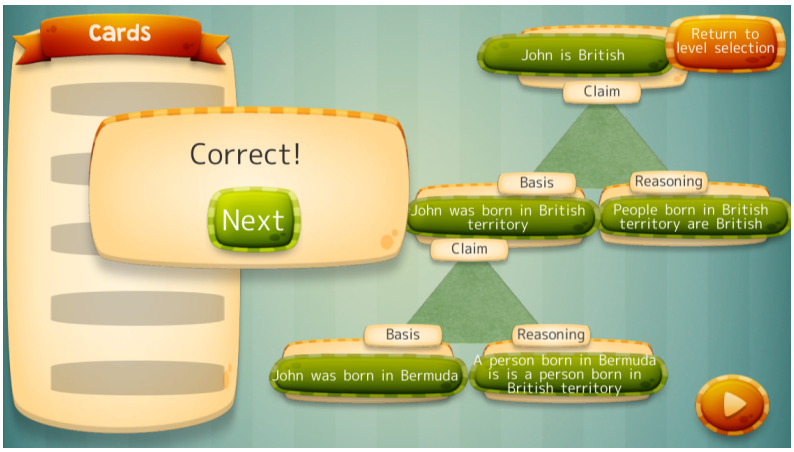

Fig. B.3 The question has two levels of recomposition.

B.2 Control Group Exercise

The questions which are asked in this section contain one or more statements and these statements are followed by two or more conclusions. You have to find out which of the conclusions logically follow from the given statements. The statements have to be taken true disregarding commonly known facts.

Statement: Many Americans are rich: Which claims can be made:

- all Americans are rich.
- some Americans are rich. (Correct)
- some Americans are not rich.
- none of the above.

Statements:

- All mangoes are golden in color.
- No golden-colored things are cheap.

Conclusions:

- All mangoes are cheap.
- Golden-colored mangoes are not cheap.

- Only conclusion I follows.
- Only conclusion II follows (Correct).
- Either I or II follows.
- Neither I nor II follows.
- Both I and II follow.

Statements:

- Every minister is a student.
- Every student is inexperienced.

Conclusions:

I Every minister is inexperienced.

II Some inexperienced are students.

- Only conclusion I follows.
- Only conclusion II follows.
- Either I or II follows.
- Neither I nor II follows.
- Both I and II follow (Correct).

Statements:

- All men are vertebrates.
- Some mammals are vertebrates.

Conclusions:

1. All men are mammals.
2. All mammals are men.
3. Some vertebrates are mammals.
4. All vertebrates are men.

- Only (4).
- Only (2).
- Only (3) (Correct).
- Only (1).
- Only (1) and (3).