# PRELIMINARY INVESTIGATION ON THE EFFECTIVENESS OF A THINKING SKILL TRAINING IN INDONESIA: “THINKING SKILLS TRAINING WITH DIGITAL TECHNOLOGY

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# PRELIMINARY INVESTIGATION ON THE EFFECTIVENESS OF A THINKING SKILL TRAINING IN INDONESIA: "THINKING SKILLS TRAINING WITH DIGITAL TECHNOLOGY"

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*Abstract*
*One main problem in Indonesia such as low educational achievement of school students was thought to be due to a general lack of thinking skills. As an attempt in addressing this problem, the present study aims to develop a thinking skill training with digital technology. The training covers materials on critical thinking principles, Socrates reasoning method, experiential learning, and experimental method. This is a quasi-experimental study with pretest and posttest and a passive control group. The outcome measures were verbal intelligence and non-verbal intelligence tests. The data were analyzed with analysis of covariance. There were forty participants in this study. The participants' age ranged from 13 to 19 years old with an average of 14.5 years old (SD=1.34). A significant difference was found between the experimental and control group for the verbal intelligence test, but not for the non-verbal intelligence tests. Thinking skills training with digital technology successfully improved the thinking skills of the participants as indicated by the significant improvement of verbal intelligence. Although the results seem promising, further investigation with randomized controlled trial, different measurements, and more training sessions are required before drawing any definitive conclusions.*

Keywords: critical thinking; thinking skill training; verbal intelligence; non-verbal intelligence; digital technology

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## Introduction

Thinking skills are often regarded as key skills to be successful in higher education (Kuh, Kinzie, Schuh, & Whitt, 2010) and career (Heimler, Rosenberg, & Morote, 2012; Parham, Noland, & Kelly, 2011). An employer and employee survey conducted in Indonesia indicates that employees with thinking skills are rare and in great demand (Gropello, Kruse, & Tandon, 2011). Similar state of demand exists in the Indonesian education system. According to the Programme for International Student Assessment (PISA) and Trends in International Mathematics and Science Study (TIMMS), Indonesian education is considered to be below par. Indonesian education experts understood the report as a warning sign, and they understandably called for more attention on thinking skills training in Indonesian education (Napitupulu, 2013). The lack of thinking skills among Indonesians has been considered to have influenced the society at large, which is portrayed in some aspects such as citizens' lack of concern on traffic safety (despite full understanding of the risks involved) and rash decisions made by government officials (Wahyudi, 2013). Many Indonesian academicians are worried that this thinking skills problem will ultimately spread to other aspects of the society. As an attempt to address this problem called by Indonesian education experts, we developed a training program for thinking skills and test it.

As an important first step towards the program development, the definition of thinking skills and how it should be measured is considered. Measuring thinking skills is difficult because the definition lacks consensus (Beyer, 1984). A pragmatic definition of thinking skills would be by using intelligence quotient (IQ) tests as thinking skills measu (Stanovich, 2009). Despite criticisms of defining thinking skills in terms of IQ tests (Duckworth, Quinn, Lynam, Loeber, & Stouthamer-Loeber, 2011; Stanovich, 2009), IQ tests have its own attractive pragmatic values as a proxy measure of thinking skills. IQ scores are correlated with educational achievement, employment prospects, career outcomes, and well-being (Sternberg, Grigorenko, & Bundy, 2001). Therefore, increasing thinking skills in terms of IQ scores may positively influence those factors.

Although IQ scores can be an attractive measure of thinking skills, it cannot serve to guide the training material. Thus, another definition of thinking skills that can be used to guide the material for the thinking skills training is

required. One definition of thinking skills that can serve this purpose is critical thinking (Facione, 1990). Critical thinking is a general term for a wide range of cognitive skills required to identify, analyze, and evaluate arguments and truth claims, discover and overcome personal biases, formulate and present reasons to support a conclusion, and make reasonable decisions about what to believe and what to do (Bassham, Irwin, Nardone, & Wallace,2011).

**Objective**

The aim of this study is to develop and test a thinking skills trainingthat would increase thinking skills. The training is based on critical thinking principles, Socrates reasoning method (Kahn, 1998), experiential learning, and experimental method. It would make use of the current affordances of digital technology. Specifically, the efficacy of the training would be investigated through quasi-experimental design with pre- and posttest and control group. The experimental and control group were tested twice in a period of three weeks. The control group did not receive any training. The efficacy of the training would be evaluated by the differences between pre- and posttest scores of the experiment group controlling for the scores ofthe control group.

## Method

*Participants*

There were 58 participants from the SM orphanage and 23 from the PH orphanage. The participants from the SM orphanage were assigned as the experimental group that received the training, while orphanage members of the PH orphanage were assigned as the passive control group. After the pretest session, 20 participants from each orphanage were selected for the study to create an equal control group. Other participants were excluded due to lack of serious participation, unwillingness to participate due to various reasons (e.g. need extra time to study for upcoming national exams (N=18), have extra-curricular activities (N=22), and some were randomly excluded to create an equal number of experiment and control group (N=8).

Participants from both groups were in the age range of 13-19 years (m=14.5 years old, SD´=1.34), showed consistent results in pretest, and were willing to give full participation on the research. All the 20 participants from

SM orphanage house were female (experimental group) and the 20 participants from PH orphanage house were male (control group).

*Ethical Statement*

This study was approved by the Human Research Ethics Committee of Institute for Research and Academic Publications, Tarumanagara University, Indonesia. We obtained written informed consent from the head of SM orphanage house in Tegal and PH orphanage house in Slawi, both are located in Central Java, Indonesia. The head of the orphanage house was the guardian and caretaker of the children (member of the orphanage house).

*Instruments*

*Cattel's Culture Fair Intelligence Test (CFIT).* This study used the adapted Indonesian third version of the test Cattel's Culture Fair Intelligence Test (CFIT) (Cattell & Cattell, 1959). CFIT is an intelligence test that is relatively free from language and cultural influence. This test is composed of four sub-tests with different tasks on each sub-test (series, classifications, matrices, and conditions). The test is viewed as an acceptable measure of fluid intelligence with acceptable reliability (Kaplan & Saccuzzo, 2012). We did not use the raw scores, but the adapted score based on the Indonesian norm of the test.

*Tarumanagara Children and Adolescent Verbal Intelligence Test (TCAVIT).* The Tarumanagara Children and Adolescent Verbal Intelligence Test (TCAVIT) is a newly developed test of verbal intelligence for children and adolescents in Indonesia. One of the main reasons for the development of this test is the problem that is often encountered by the adapted version of verbal intelligence test from Western tests, which are translation problems and cultural differences. TCAVIT consists of inductive and deductive syllogism. It has 20 multiple choice questions with 4 answer options. Internal consistency reliability (α=.69) has been shown to be acceptable among Indonesian children and adolescents (Jap, Tiatri, Jaya, & Arjadi,2013).

*Tarumanagara Children and Adolescent Non-Verbal Intelligence Test (TCANVIT).* The Tarumanagara Children and Adolescent Non-Verbal Intelligence Test (TCANVIT) was developed based on the idea of culture free intelligence test originally advocated by Raven and Cattell (Kaplan & Saccuzzo, 2012). The test consists of induction and deduction reasoning from

pictures. There are 17 multiple choice questions with 4 answer options. Similar to TCAVIT, acceptable level of internal consistency reliability (α=.68) has been reported with Indonesian children and adolescents population (Jap et al., 2013).

*Thinking skills training with digital technology*

The construction of the thinking skills training is mainly but not exclusively based on the principles of critical thinking, Socrates reasoning method, experiential learning, and experimental method. These principles are then applied through the use of digital technology instrument, a digital camera. The training was conducted in a group format. Each group consisted of five participants.

There are various principles of critical thinking used in this training. The principles of critical thinking are delivered at the first, second, third, and fifth training session. The first training session present the definition and standard of critical thinking according to Bassham, Irwin, Nardone, and Wallace (2011). Their definition of critical thinking consists of clarity, precision, accuracy, relevance, consistency, logical correctness, completeness, and fairness. Each of these terms is discussed and given relevant everyday life examples. The second session discusses inductive reasoning, which is then followed by a practice session on inductive deduction with digital camera. The third session covers materials on deductive reasoning. This is also followed by a deductive reasoning practice sessions with digital camera. The fifth session discusses categorical syllogism. The participants are taught to dissect sentences into categories and examine it for logical flaw(s). After that, the participants receive discussion materials and exercises. The purposes of these activities are to train the participants to critically examine arguments using categorical syllogism approach. For example: "Some lawyers are not swimmers. All lawyers are law graduates. Therefore, some law graduates are not swimmers. True or False?" The participants are required to draw the categorical logic with circles and answer correctly.

The Socrates reasoning method, particularly Socratic questioning, is employed in the communication between trainers and participants. This method plays a major role in training critical thinking (Paul & Elder, 2006) . It is used particularly when participants meet difficulties in understanding abstract concepts. The trainer would then ask the participants in a Socratic questioning manner. However, the Socratic questioning method is not used when the

participants have technical problems (e.g. problems with the cameras).

The experiential learning paradigm in this training is embedded in the use of digital technology. The experiential learning paradigm demands that the students learn the process of adapting things from the environment/surroundings (Kolb, 1984). The training places the participants in an environment where critical thinking is a required adaptation. This forces the participants to use their thinking skills. However, unlike the usual paper and pencil logical exercises, the training purposefully exposes the participants to environment reflecting real life problem. The training utilizes the new affordances of technology, which are DSLR camera and tablet computer. The induction and deduction practice session are made of problems that are often met by professional digital photographers, which requires induction and deduction to solve. We believe that curiosity and engagement will arise in such settings, thus increasing their utilization of thinking skills.

This environment is created through two main features of the DSLR cameras, which are ISO and shutter speed. These features are normal variables that professional photographers should always adjust. ISO and shutter speed are about the amount of light a photograph is needed. The ISO is the film sensitivity towards light. Higher ISO will make the film is more sensitive towards light. The increased sensitivity camera enables the photographer to take pictures in low-light environment, but the downside is that the picture taken will be grainy and not clear. On the other hand, decreasing the ISO will reduce the film's sensitivity towards light and will result on a smoother and finer picture. The photographer must be able to detect which ISO is appropriate for a situation. The other feature, shutter speed, is also a light variable. The shutter speed option adjusts the speed of the opening of the shutter in seconds. The longer the shutter speed is opened, the more light the film receptor received. More light will create a brighter picture and enable the photographer to take pictures in a low-light environment. However more light will also capture more movements, both the movement of the object and the movement of the camera. Thus, adjusting the light in a photograph requires analyzing the light situation in a given environment and tweaking the ISO and shutter speed control.

Placing the participants in such environment forces them to adapt by developing experimental skills. They are forced to form hypotheses through deductive and inductive reasoning from the data (the light environment,

movement, shutter speed, and ISO). The hypotheses can be tested almost instantly, which give the participants instant feedback on their way of thinking. When their hypothesis results in a picture that is too dark or too light, they have to revise their hypothesis and test it again by taking another picture.

The short amount of time required for the feedback and its nature is of utmost important. A feedback that takes too long will not be as helpful as an instant feedback, since the participants might already forget about their mistake. Instant feedbacks are of central importance in modifying behaviors (Ferster & Skinner, 1957). Moreover, the nature of feedback in the digital camera training is always objective. It is not given by human. This is important to avoid the problem of multiple and non-standardized answers across trainers. Therefore, this will help in assuring the participants to have standardized thinking skill through the participation of the training.

*Procedures*

We conducted a pretest session to all the initial set of participants from SM orphanage house (N=58) and PH orphanage house (N=23). Then, 20 participants from SM orphanage house were selected for the experimental group and 20 participants from PH orphanage house for the control group. The training consisted of 8 sessions that was conducted twice a week in the weekend (Saturday and Sunday), each for approximately 2 hours. The first session was for pretest, and the last session was for posttest.

The independent variable was the thinking skills training with digital technology and dependent variable was thinking skills. The hypothesis was that the thinking skills training with digital technology would enhance thinking skills.

*Research Design*

This was a quasi-experimental study with pretest and posttest control group (Kerlinger & Lee, 2000). There were two groups involved in this study, one experimental group and one passive control group. Before the training, participants were informed about the nature of the research, session plans, and the confidentiality of their identity in later publication of this study. The participants received incentives in the form of snacks at the end of every two sessions.

*Data Analysis*

The data was first tested for normality using Kolmogorov-Smirnov, then analyzed using analysis of covariance (ANCOVA). The posttest scores between the experimental and control group was analyzed for differences, while making the pretest scores from both groups as the covariate. This method of analysis is recommended for pre- test posttest non-randomized control group design (Dimitrov & Rumrill, 2003; Huck &McLean, 1975).

## Results

*Descriptive result*

The participants' age ranged from 13-19 years old. The mean age for the participants was 14.5 year old (SD=1.34). There were 20 female participants in the experimental group and 20 male participants in the control group. The mean of the CFIT for the experimental group at pretest was 106.45 (SD=8.78) and the mean for the control group was 98.40 (SD=20.02).The mean score of the TCAVIT at pretest for the experimental group was 12.45 (SD=2.76) and for the control group was 10.40 (SD=4.06). The mean score of the TNCAVIT at pretest for the experimental group was 8.00 (SD=2.60) and for the control group was 8.90 (SD=3.71). The descriptive result of the participants´ characteristic is available at Table 1.

Table 1. Participants' characteristic

| Characteristic | Mean (Standard Deviation) |
|---|---|
| *Experimental group* | |
| Age | 14.2 year old (SD=0.89) |
| CFIT | 106.45 (SD=8.78) |
| TCAVIT | 12.45 (SD=2.76) |
| TNCAVIT | 8.00 (SD=2.60) |
| *Control group* | |
| Age | 14.8 year old (SD=1.64) |
| CFIT | 98.40 (SD=20.02) |
| TCAVIT | 10.40 (SD=4.06) |
| TNCAVIT | 8.90 (SD=3.71) |

Table 1. Participants' characteristic - *continued*

| Characteristic | Mean (Standard Deviation) |
|---|---|
| *Combined* | |
| Age | 14.5 year old (SD=1.34) |
| CFIT | 102.43 (SD=15.80) |
| TCAVIT | 11.43 (SD=3.58) |
| TNCAVIT | 8.45 (SD=3.19) |

Note: CFIT (Cattel's Culture Fair Intelligence Test); TCAVIT (Tarumanagara Children and Adolescent Verbal Intelligence Test); TNCAVIT (Tarumanagara Children and Adolescent Non-Verbal Intelligence Test)

*Training effect*

The training's effect was examined by looking at the differences between experimental group and control group, while holding the pretest scores as covariates. The descriptive statistics for the pretest and posttest scores is shown in Table 2. The three measures in this experiment were analyzed separately. The CFIT showed no significant statistical difference between the experimental group and control group ($F(1, 37)=0.02$, $p>0.05$, *partial* $\eta^2=0.00$). Both groups had an increased score at posttest. Similarly, the non-verbal intelligence test showed no significant statistical difference ($F(1, 37)=0.09$, $p>0.05$, *partial* $\eta^2=0.00$). But, the verbal intelligence test showed significant statistical difference between the experimental group and the control group ($F(1, 37)=7.68$, $p<0.05$, *partial* $\eta^2=0.17$).

Table 2. Pretest and posttest mean and standard deviations

| Measures | Pretest | Posttest |
|---|---|---|
| *Experimental* group | | |
| CFIT | 106.45 (SD=8.78) | 111.80 (SD=10.77) |
| TCAVIT* | 12.45 (SD=2.76) | 13.30 (SD=2.30) |
| TNCAVIT | 8.00 (SD=2.60) | 8.75 (SD=3.45) |
| *Control group* | | |
| CFIT | 98.40 (SD=20.02) | 105.75 (SD=17.71) |
| TCAVIT* | 10.40 (SD=4.06) | 10.15 (SD=3.67) |
| TNCAVIT | 8.90 (SD=3.71) | 9.15 (SD=3.16) |

Note: CFIT (Cattel's Culture Fair Intelligence Test), $F(1, 37)=0.02$, $p>0.05$, *partial* $\eta^2=0.00$; TCAVIT (Tarumanagara Children and Adolescent Verbal Intelligence Test), $F(1, 37)=7.68$, $p<0.05$, *partial* $\eta^2=0.17$; TNCAVIT (Tarumanagara Children and Adolescent Non-Verbal Intelligence Test), $F(1, 37)=0.09$, $p>0.05$, *partial* $\eta^2= 0.00$;*$p<0.05$

## Conclusion

The result showed that 'Thinking skills training with digital technology' has an effect on verbal intelligence measure. There is a statistically significant difference between experimental group and control group on verbal intelligence measure, but not on the non-verbal intelligence test. In other words, the hypothesis was supported for the thinking skills measured by Verbal Intelligence Test, but was not supported for the thinking skills measured by Non-Verbal Intelligence tests. This result can be interpreted that eight sessions of thinking skills training in four weeks have an effect on verbal reasoning capability (as measured by the verbal intelligence test), but not on general reasoning capability (as measured by the non-verbal intelligence test).

Furthermore, the results are in line with the findings of Hopson, Simms, and Knezek (2001). They found that computer technology-enriched classroom environment has a positive influence on higher-order thinking skills. In addition, we showed that enrichment through different technology such as digital camera and tablet also serve a similar function like computer. Moreover, the effect of technology enrichment seem to be able to generalize across context as we showed that it also has a positive influence on higher-order thinking skills in orphanage home.

The exclusive effect on the participants' verbal reasoning capability can be explained by the over-emphasis of the training material on verbal reasoning. The role of the trainers is to reason and question the participants' way of thinking. This forces the participants to develop verbal reasoning capability.

Despite the seemingly optimistic result, there are several limitations that made the results are difficult to interpret. First and foremost is the lack of active control group. At the time of designing the study in 2012, the issue with quasi-experimental design in cognitive training discussed by Boot and colleagues (2013) has not been raised. Future study should rule out the possibility of placebo effect by examining the training under randomized control group design with a good active control group. Secondly, the results may perhaps be dependent on the measures that were used. Another useful consideration for future study would be to modify the length and intensiveness of the training. A longer and more intensive training may provide stronger effect.

To conclude, this study showed that thinking skills training with digital

technology has the potential to increase thinking skills as measured by verbal reasoning. However, further investigation with stronger design is needed to draw a more definitive conclusion.

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