Cognitive Flexibility Categorization in Moral Dilemma Decision

Hartanto Hartanto
Faculty of Psychology, Universitas Gadjah Mada, Indonesia
Email: hartanto@mail.ugm.ac.id

Imam Shofwan
Faculty of Education, Universitas Negeri Semarang, Indonesia
Email: ishofwan@mail.unnes.ac.id

Abstract

Ethical decisions have an impact on our daily life regardless of the importance of the decisions. Moral judgment processes are affected by cognitive sources and performance. Theoretically, moral cognition is always connected to mental reasoning and executive functions. Cognitive flexibility, as one of the executive functions, determines how people change and-modify their response until it is appropriate, and people's cognitive flexibilities can be distinguished using switching tasks. With their cognitive flexibility, people use their cognition to adapt and deal with stimuli. This research explored and distinguished individual responses between blocks of (picture or text) stimuli in the moral dilemma scenario. The stimuli presentation was carried out using experyment, a lightweight Python library. The research consisted of two phases. Study 1 sought to differentiate and categorize participants into high and low cognitive flexibility capacity groups using the behavioral paradigm of task switching ($p < 0.001$) and switch-trial was found to take a longer time to respond than same-trial. In Study 2, based on the average switch-cost value in the first study (mean = 922 ms), two groups were formed (the fast and slow groups). The analysis results showed a significant difference between groups and types of stimuli ($p < 0.001$; Mallow's Cp = 66.2). This finding implies that individuals who have adaptive thinking flexibility might be faster in dealing with decision dilemma than who do not. The fast-switch group was also found outperforming the slow-switch group in both moral image ($p < 0.05$; z ratio = 2.650) and text tasks ($p < 0.05$; z ratio = 4.119). This study shows that a lab experiment with a noncomplex paradigm is adequate to detect and predict more complex decision-making such as in moral dilemmas.

Keywords
Cognitive flexibility, moral judgment, cognitive task, executive function

1. Introduction

Studying moral cognition through moral judgment has become the core methodology in morality research. People's moral judgment is affected by internal (Christensen et al., 2014; Dedeke, 2015) and external factors (Armstrong, 2008; Hales, 2009; Curry, 2016). The latter could easily affect young people's morality due to its flexible form (e.g.,.social media). Several studies found that social media negatively impact moral virtue (Morgan et al., 2017; Gorelik & Shackelford, 2016), while others reported it as having both negative and positive impacts (Akram et al., 2015; Siddiqui & Singh, 2016; Celik, 2018). Being part of moral virtues, moral judgment plays a vital role in directing people's moral behavior. Behaviors like smoking in a public place, killing animals for fun or competition, intolerance movement, making or delivering false news (hoax) for personal or group benefit involves different mental calculations (pros vs. cons) between individuals. Such individual response differences appear and occur presumably due to differences in cognitive activity

Moreover, as previously mentioned, internal factors, such as cognitive flexibility, formed as higher-order cognitive ability, affect moral judgment. For several decades, moral cognition has always been connected to mental reasoning, logic, and more recently, emotion (Killen & Smetana, 2008; Albertzart, 2013; Lin et al., 2014). Hypothetically, individuals who perform a high degree of cognitive flexibility functioning show appropriate moral cognition and moral judgment. People may think and react with different rules in different tasks/conditions assuming higher moral judgment than those who do not. Consequently, the participants can be divided into two or more categorizations based on their cognitive flexibility ability scores (i.e., low and high). Similar cognitive flexibility categorizations were also found in children (Japha et al., 2010; Chan & Morgan, 2018).

Moral judgment has also been reported positively with prosocial behavior and negatively with antisocial behavior (Hardy et al., 2015) according to which people endorse certain behaviors and attitudes in the prosocial domain or antisocial domain, suggesting that moral judgment involves cognitive and emotional activities. However, in a moral dilemma scenario, people are being faced with a dilemma where they have to choose between good responses or, to be specific, between prosocial and higher prosocial responses, or, likewise, between bad response and worst response. I developed this by adding it with moral domain (animal in need, education, bullying, and famine) in both types of stimuli: image and text. This theme was divided into two primary stimuli in the moral domain (see phase 2). Both stimuli types contained dilemmas between themes; comparing helping the animal in need or helping children for better education, for example.

Research on morality has many obstacles since it is tied to evaluation formed as to whether some behavior, motive, trait, and character in a person is bad or good against a standard value measure so that measurement of a moral virtue can generate a systematic error or cognitive bias (Caviola et al., 2014; Freitas & Johnson, 2018) notably in collectivist cultures (Curry, 2016). To minimize systematic error and increase the validity, this present research used human-computer interaction to deliver the stimuli and collect the data, even though there were earlier moral judgment studies that used the human-computer interaction approach (Paxton et al., 2011; Christensen et al., 2014) but limited to examining the participants' responses to the stimuli and not recording the reaction times required to respond the image or passages stimuli.

Phase 1: Cognitive Flexibility Measure

Since cognitive flexibility is part of the primary executive function construct, it can be measured in a lab setting (Ravizza & Carter, 2008; Herd et al., 2014; Zhai et al., 2014). This present research used recursive different cognition tasks to measure cognitive flexibility. However, the cognitive tasks met the common criterion of having the ability to distinguish and discriminate attention thinking. This criterion was based on reward-prediction error theory (Schultz, 2016; Hauser. et al., 2015), according to which people expect more or less reward than what they will actually get, and thus their attention and thinking might be adaptive and flexible in nature. The cognitive tasks that were used to differentiate cognitive flexibility scores were based on a switching-between-blocks rule. The tasks consisted of blocks of letter-digit stimuli. The changes in the reaction times from the shift trial (switch cost) were examined to calculate mean differences. The paradigm of set-shifting examines the differences of performance between repetitive-trial (same trial-based) vs. switching-trial (different trials-based) (Dajani & Uddin, 2015; Yerys et al., 2015).

Phase 2 moral image and passages stimuli

In everyday life, people make judgments to deal with various choices and problems. With the widespread use of social media, judgments could be delivered through various materials in the form texts (articles, passages, public opinions, etc.) and/or images. There are advantages and disadvantages to using images and texts as stimuli. Image recognition task has more advantages over text or passage because an image can be accessed directly by individuals even when they are experiencing fatigue so that it has a higher validity. However, a moral image delivers one message only, whereas a moral passage can deliver multiple messages. Besides, a passage can be more complex than an image to explain a phenomenon. This study used six pictures and passages with moral contents (animal in need, education, bullying, and famine) as stimuli. Each picture stimulus contains two images in side by side position (i.e., animal help vs. bullying). Meanwhile, each passage stimulus presents two response options to choose from.

2. Literature Review

Many studies have been done regarding the relationship between moral behavior and cognitive activities. To be specific, research in cognitive flexibility as part of the executive function with morality has been carried out with various methods. Some of the common ones are developmental psychology approaches. Executive function has been shown to moderate the development moral maturity in a sample of children (Vera-Estay et al., 2016). More specifically, research from Romero-Lopez (2018) examines executive functioning with problematic behavior in student school using path analysis. The path analysis found accurate results that cognitive flexibility predicts barriers to social interaction through adaptation and social skills (Djibu et.all, 2019). Similar research was also conducted by Ashrafi and Estaki (2013) regarding cognitive flexibility with moral development. This study has a method that is almost the same as researcher used in this study, except for the assessment tools used. In the above research, the measurement of cognitive flexibility as part of the executive function was carried out with the Wisconsin Sorting Card Task (WCST). In contrast to the study review above, this research uses the cognitive flexibility task letter-word paradigm to assess cognitive flexibility (Shofwan et al. 2021). The results also showed

a positive correlation between cognitive flexibility and moral development. In their study, Hinnant et al. (2013) examined the relationship between executive function and moral reason in cooperative dyads. Children who have high executive function scores are also correlated with high moral reason scores. Where the low emotional regulation variables also correlate with low morality scores. All research above using regression-based method to analyze data and also answer the hipothesis. In contrast, this study try to grouping subject into three level cognitive flexibility based-on their ability when perform the cognitive flexibility task then analyze the variasn of the score from three level categorisaztion in correspond to the moral dilemma task.

2.1. Cognitive flexibility

Executive functions as the home of this cognitive dimension are also often studied through other dimensions, including inhibitory control, working memory, and cognitive flexibility. Research on cognitive flexibility has been done less often than inhibitory control and working memory. However, from the findings of several studies (Martin & Rubin, 1995; Oshiro et al., 2016) it can be concluded that the aspects of cognitive flexibility are as follows: 1) Awareness: the point where the individual feels some inaccuracy in their responding and are aware of several options and alternatives. 2) Willingness: the individual's intention to produce an appropriate response; some individuals may have high alertness and sensitivity, while some fail to improve their response because they are not motivated either internally or externally. 3) Self efficacy: the individual's belief in their ability to continue the process of maintaining the new response. In cognitive tasks, there are switching block stimuli and maintaining block stimuli. Unlike working memory, which has a large variety of cognitive tasks, cognitive flexibility can only be studied using cognitive tasks with the task- switching paradigm. The task-switching paradigm is presently divided into the probabilistic reversal learning task and the Wisconsin card sorting task. Cognitive flexibility requires high brain energy so that in a long run may affect its performance (mental workload) (Causse et al., 2017).

2.2. Moral Dilemma

Almost all research on morality uses the moral decision models framework from Joshua Greene (2015) (Dual Process Theory, Utilitarian vs Non-Utilitarian/Deontological) and Jonathan Haidt (Social Intuitionist Model) as the basis of moral decision concept. For almost a decade, there have also been arguments among moral psychology figures regarding intuition-based and rationale-based moral decision making and the contribution of the moral dilemma variable (switch problem) in the setting of personal or impersonal scenarios. Haidt (2001) argues that there are at least three essential characteristics, indicating that moral decisions tend to be attached to emotion and intuition. First, moral decisions are made unconsciously because they are controlled and supplied by emotional data rather than cognitive data. According to Haidt, only people with higher levels of thought reflection such as philosophers and thinkers can use their rationality in a balanced way. Second, rationality only appears as an explanation or "refinement" after a moral-emotional decision has been established. Lastly, the rational view will be used with special conditions, namely when there is a conflict between intuitions (counter-intuitive). For example, an individual who saw a carnivorous animal eating a herbivorous animal and compared it with a herbivorous animal killed by a human will experience a moral intuition conflict which may lead to rationalist reflection. On the other hand, the dual-process model has a theoretical claim that all moral decisions are affected by cognitive activities and thus leads to a consequentialist response (Greene, 2015). The consequentialist school is also known as the utilitarian judgment school. In contrast to intuition-based moral decisions, this decision is rationally based in the sense that the response is made based on the greatest benefit or the smallest risk consideration. If your reason for obeying the social distancing and wearing mask protocol is because you are thinking about the future effects then it can be considered a utilitarian moral decision (Everett et al., 2020). Moral utilitarianism is widely echoed because it is a manifestation of reason in moral decisions. Both intuition and rationality are the main approaches to moral decisions.

3. Method

The participants were 30 college students (Mean = 21.7, SD = 0.95). No health issues were reported, and all participants have a good visualization. This study was divided into 2 phases. Study 1 sought to categorize participants' cognitive flexibility by using two different tasks (see tables 1 and 2). Study 2 analyzed the differences in cognitive flexibility based on each group's response to the moral image stimuli the categorization of which was determined based on the reaction time means (see tables 3 and 4). However, due to the pandemic situation that made it difficult to use the lab and clearance, data collection was carried out at once. In taking participant data, 43 subjects were successfully contacted, but only 30 data subjects could register.

First, the subject enters the lab room and briefly explained the study's description, procedures, and benefits. Second, when the subject is ready, the subject sits facing the computer with a distance of 30 cm from the screen and begins to read the instructions on the computer. After understanding the instruction, the subject might continue to press the space keyboard and fill in the training session for the cognitive flexibility task. After the first task is completed, it continues with the second stage, the moral dilemma task, which has instructions that are the same as the first task. However, in the moral dilemma task, there are no training sessions

3.1. Cognitive Flexibility Task

In neuropsychological task assessment, cognitive flexibility is often studied in the task-switching or set-shifting paradigms. Two well-known cognitive tasks used to investigate cognitive flexibility are the letter-number switch task and the Wisconsin Card Sorting Test (WCST) (Vandierendonck et al., 2010; Soveri et al., 2013). Cognitive tasks in the form of letter-number stimuli were used in this present research because they are more suitable for non-clinical sample participants. The stimuli were presented in four quadrants; in the upper half quadrant, the participants were required to respond to letter stimuli, while in the lower half quadrant the participants were required to respond to number stimuli. In the same-trial, the same stimulus was presented twice or more in the upper or lower quadrant, while in the switch- trial the stimulus was moved from the upper to the lower quadrants, or vice versa (Ward, 2015).

3.2. Moral Dilemma Stimuli

The moral dilemma stimuli consisted of six passages and images. The picture stimuli ensembled four images with bullying, helping animal, education, and famine themes, so there were six combinations (bullying vs. helping animal, bullying vs. famine, and so on.). The stimuli had been validated and tested with five participants for clarity and content. The pictures were retrieved from Google and Pixabay under Creative Commons licenses. The moral dilemma passage stimuli written in Indonesian language and also contain the same themes as in image based. These stimuli presented in computer screen side by side (right and left fixation) and partisipant ask to select which image needs help more than the others. The "A" keyboard for the image in the left and "L" keyboard for the right image. These keys respond also done in text stimuli. The instruction was the same for the passages stimuli. After partisipant choose the answer, the next button will appear and partisipant will see the next stimuli.

3.3. Experiment Process and Data Analysis

The experimental procedures were described to the participants before they proceed to enter the experiment class, one by one. Each participant was asked to focus on the laptop screen. Before the experiment began, the participants were required to read the task instructions carefully to be considered eligible to proceed. Dell Inspiron laptop with i3 core 2.0 GHz, 8 GB memory ram and a 14-inch monitor 60 Hz refresh rate was used as the experiment aid. The experiment was carried out using Expyriment, a lightweight python library for behavioral neuroscience (Krauss & Lindemann, 2014). ANOVA-GLM was calculated using R Programming.

4. Results and Discussion

Data were collected from a total of 30 student participants from Universitas Widya Dharma. After exported from .xda file to .csv file, the data were processed using the average limit of switch-cost (mean= 922 ms) between the same trial and the switch-trial. The result showed that 14 participants belonged to the slower group, while the remaining participants belonged to the faster group.

4.1 Learning Process

Overall, the response in the same-trial was faster than the switch trial with mean value in same-trial is 1469.7 ms and switch-trial is 2393.4 ms (table). As explained by the cognitive flexibility theory, same-trial is processed faster because of the non-complexity of the task compared to switch-task. In other words, any cognitive task that uses repetitive and sequential trials is easier to respond than tasks that use simultaneous switch sequences.

Table 1. Reaction Times on the Same-Trial and the Switch Trial

	Type of Trial	
	Same-Trial	**Switch-Trial**
RT (millisecond)	1469.7	2393.4

In the cognitive flexibility task between letter and digit stimuli, it was-found that vowel stimuli (mean RT=1703 ms) were responded faster than consonant stimuli (mean RT=2054 ms) also in digit-odd stimuli (mean RT=1809 ms) and digit-even stimuli (mean RT=2089 ms) (table 2). This finding suggests that, in term of flexibility, vowels are easier to respond to and recognize than consonants when paired with other stimuli such as numbers. In addition, odd number stimuli that were paired with letters were responded faster than even number stimuli.

Table 2. Average Reaction Times Between Digit and Letter Trials

	Trial ID			
	Digit-Even	**Digit-Odd**	**Letter-Vocal**	**Letter-Consonant**
RT (millisecond)	2089.6	1809.9	1703.7	2054.8

The overall reaction times required to accomplish the cognitive flexibility task were divided into two groups. The mean value of each group was calculated based on the switch-cost mean, as the demarcation line. From table 3 we can see that the fast-switch group was faster than the slow-switch group. This finding can be conclude that cognitive flexibility could reflect the actual differences between two group (fast vs slow flexibility performances) using mean RT as demarcation line. This grouping was necessary to carry out the second phase of research.

Table 3. Average Reaction Times of Fast-Switch and Slow-Switch Groups

	Group	
	Fast-Switch	**Slow-Switch**
RT (millisecond)	5088.6	6303.3

Table 4. Average Reaction Times Between Groups and Types of Stimuli

Type of Stimuli	**Group**	**Mean (millisecond)**
Image-based	Fast-TS	2672.9
Text-based	Fast-TS	7503.5
Image-based	Slow-TS	3573.5
Text-based	Slow-TS	9033.2

Table 4 shows the average reaction times of each group. From this point of view, the fast task-switching group (Fast-TS) was faster than the slow task-switching group (Slow-TS) on both types of stimuli (table 4). In line with the theory that posit cognitive flexibility is the ability to deal with the problem and find a solution. Adaptibility as a core in cognitive flexibility is found to be differ across group between fast task-switch and slow task-switch.

4.2 Graphical Results

Figure 1 mainly describes the mean value between the same-trial and switch trial. From the barplot, it can be seen that the same-trial performance is faster than the switch-trial performance. This is a normal phenomenon because at the time of the trial switch, the participants start the rules from the beginning again and have to adapt as soon as possible and this behavior cost in more reaction times. This figure 1 exactly shows the data as table 1.

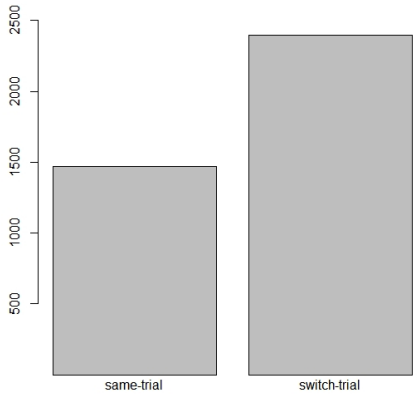

Figure 1. Bar plots of the Switch-Trial and the Same-Trial

Figure 2 explains that fast-TS is the group where the reaction time is above the mean value, while slow-TS is the one below the mean value. The mean value is taken from the overall score of completing the cognitive switching task. This figure 2 exactly shows the data as table 3.

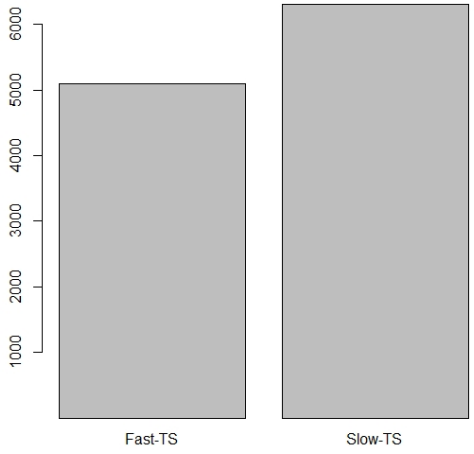

Figure 2. Bar plots of Fast-TS and Slow-TS Group

Figure 3 describes the flow of the switch task. The sequence from stimulus, the fixation point and the next stimulus is referred to as ITI (inter trial interval). Meanwhile, from stimuli to fixation point it is called ISI (inter-stimulus interval).

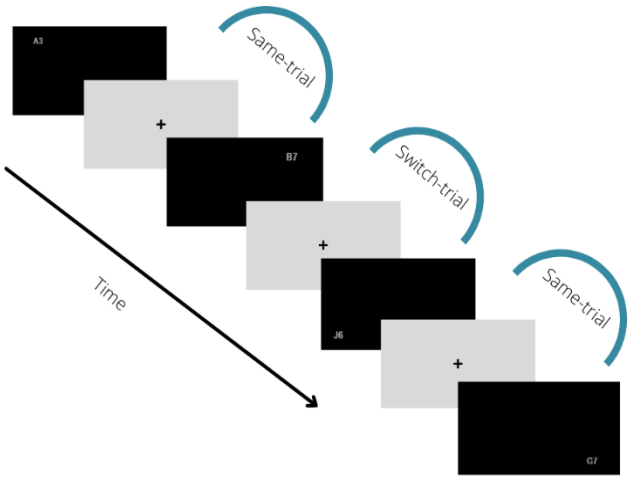

Figure 3. Switch Task

The Shapiro-Wilk test result for the switch-cost was 0.75 ($p > 0.001$; $w = 0.978$), indicating that switch the cost data distribution was normal. The result of the one-way ANOVA analysis the result was significant ($p < 0.0002$, $F = 63.79$). This finding suggests that the mean value of the switch-trial was found to be larger than that of the same-trial. The participants' response latency was longer in the switch condition due to the different locations and stimulus types (Moradzadeh et al., 2015). To accomplish the new stimuli individuals, need to be aware of and maximize the flexibility in their thinking about their response (Gabrys et al., 2018).

After categorizing the subject into two groups (slow-switch and fast-switch) and cleaning the data, ANOVA generalized linear model (ANOVA-GLM) using gamma distribution was applied. Although gaussian ANOVA is robust against non-normally distributed data, using a more appropriate type of distribution and method is more preferable. ANOVA GLM was used to compare the mean differences of the slow-switch and fast-switch reaction times between groups ($p < 0.001$; Mallow's Cp = 150.96; Constant Mallow's Cp = 154.943) and image versus text stimuli between blocks ($p < 0.001$; Mallow's Cp = 70.2; Constant Mallow's Cp = 154.943). Mallow's Cp is a technique to assess ANOVA models like AIC or BIC. The Mallow's Cp value has to be closer or below a constant value to show that model is fit. The statistical analysis showed that the model is fit and also significant. This means that there was a significant mean difference between the slow-switch and fast-switch groups corresponding to the moral dilemma (see table 3). From visual inspection, the bar plots (figure 2) showed that the mean discrepancy between groups was longer in the slow-switch. In line with my prediction, people with higher cognitive flexibility might be more aware of their responses and change them if not match or appropriate. They can react and choose other options to fit the demand. The essential thinking in a moral dilemma scenario is not choosing between right or wrong (Greene, 2015) and thus the task should be designed to choose between right and more right and the importance of helping (Gold et al., 2015).

In the block section, the result of the analysis of the interaction effect between groups and blocks was significant, with image stimuli being processed and responded faster than text stimuli-($p < 0.001$; Mallow's Cp = 66.2). By using lsmeans package (Lenth, 2016), a significant difference was found in the reaction times between fast-switch and slow-switch text stimuli ($p < 0.05$; est = 2.26e-05; z ratio = 2.650). A significant difference was also found on the image stimuli ($p < 0.05$; est = 9.43e-05; z ratio = 4.119). From these results, I can conclude that the fast-switch group outperformed the slow-switch group on both text and image stimuli, suggesting that under all conditions and types of stimuli, the fast-switch group's cognitive flexibility gives them an advantage that enables them to decide on the response faster. This evidence supports the finding that the fast-switch group is better in the moral dilemma conflict task. According to the theory people who have fast adaptability and problem solving skill might perform better performance comparing to its counterpart.

The task-switching paradigm in the cognitive flexibility categorization might be considered a non-complex task even though this protocol is still more complicated than the Simon task, Stroop task, or Flanker task. Studying moral behavior is a complex task, let alone in the moral dilemma decision scenario described earlier. The main finding of this present study is that non-complex paradigm approaches and lab-based studies using group categorization are quite effective to differentiate complex moral decisions. The findings also promote the development of a new, more advanced and complex paradigm that can more clearly differentiate cognitive flexibility capacities. Moreover, higher cognitive flexibility might impact the performance of other aspects of executive functioning such as working memory and cognitive control in various tasks (Buitenweg et al., 2017) and reflects the more efficient path of brain network (Herd et al., 2014). This finding will also open the possibility of a more in-depth investigation of the decisions of utilitarianism and deontology judgment in various moral dilemma scenario.

5 Conclusion

Cognitive flexibility is responsible for a lot of decision-making, problem solving skill, including moral judgment in moral dilemma scenarios. This present study demonstrates that the switch-task requires significantly a longer reaction time than the same trial. Using this result for the dichotomous group was also found effective to correspond to the moral dilemma stimuli. Individuals with higher thinking flexibility perform much better than those whose thinking is less flexible. Their awareness of their cognitive flexibility that allows them to change and modify the response helps them when they are faced with dilemmatic decision-making situations. More importantly, this research found compelling evidence that the use of a non-complex design of task paradigm in a lab setting can predict actual complex behaviors.

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Biography

Hartanto is a Doctor student of the Faculty of Psychology at Universitas Gadjah Mada, in Yogyakarta City, Indonesia. He finished his Master's degree in Psychology at the same University. His research interest includes topics in Cognitive, Emotion, Psychophysic Experiment, and Online Research.

Imam Shofwan is a Lecturer in the Department of Nonformal Education, Faculty of Education, Universitas Negeri Semarang. Besides, he also serves as the manager of 3 (three) journals (Journal of Nonformal Education with link https://journal.unnes.ac.id/nju/index.php/jne, The Journal of Social Sciences with link https://medwelljournals.com/archive.php?jid=1818-5800, Jurnal Edukasi with link https://journal.unnes.ac.id/nju/index.php/edukasi). Related to research focuses on learning strategies, learning management, and learning design. Also related to the membership that followed include Edurasia, Ikatan Akademisi Pendidikan Nonformal Indonesia (IKAPENFI).