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# IDENTIFYING INDONESIAN UPPER-SECONDARY SCHOOL STUDENTS' ORIENTATIONS TO LEARN SCIENCE AND GENDER EFFECT THROUGH THE USE OF STRUCTURAL EQUATION MODELING

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**Abstract.** *The purpose of this research is to examine Indonesian upper-secondary school students' learning orientation in science via generating structural equation modeling of conceptions of, approaches to and self-efficacy in learning science, and seeking whether the model is significantly different based on gender. A total of 600 (63% females) Indonesian upper-secondary school students completed a questionnaire with three constructs – conceptions of, approach to and self-efficacy in learning science. Rasch analysis was conducted before testing the hypothesized model to examine the psychometric aspects of the instruments. Structural equation modeling featured with multi-group analysis-based gender was used to respond to the main research purpose. Findings indicated that the Indonesian upper-secondary school students had multiple conceptions of as well as multiple approaches to science learning that led to different senses of self-efficacy. Multiple conceptions and mixed approaches are the characteristics of students with achieving orientations. Most importantly, the current research found that conceiving learning science as memorizing was considered as the basis for the higher level of conceptions. The model significantly differed based on gender. Three main differences were Indonesian female students tended to be more conceiving science learning as memorization, using more surface motive and their self-efficacy was more impacted by their higher level of conceptions – applying and understanding than males. Based on findings, gender issues in orientations to studying and Indonesian science education curriculum are discussed.*
**Keywords:** *learning strategies, conceptions of learning, gender, learning orientations, multi-group analysis, self-efficacy.*

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## Introduction

Recently, attention to students' affective constructs in learning science is increasing in the body of science education research. The increasing attention on students' affective constructs in learning science is due to the suggestions that affective constructs are positively influencing students' science learning processes (Osborne, Simon & Collins, 2003; Schumm & Bogner, 2016). Several notable constructs that recently have been scrutinized by science education researchers by displaying in the form of inter-correlation model are conceptions of, approaches to and self-efficacy in learning science (e.g. Lee, Johanson & Tsai, 2008; Shen et al., 2016; Zheng, Dong, Huang, Chang & Bhagat, 2018). These three constructs are also known in determining a student's learning orientation in science subjects (Shen, Lee, Tsai & Chang, 2016).

Students' conceptions of learning science (COLS), determined by students' previous experiences in learning science, have been evidently impacting the type of motive and strategy that students use in learning, or known as approaches to learning science (ALS) (Kember & Kwan, 2000; Lee et al., 2008; Marton, Dall'Alba & Beaty, 1993; Nijhuis, Segers & Gijselaers, 2008; Tsai, Ho, Liang & Lin, 2011; Yang & Tsai, 2010). COLS and ALS are composed of factors that are hierarchically distinguishable. In terms of COLS, Tsai (2004) based on his phenomenological analysis of Taiwanese upper-secondary school students, suggested that students conceive learning science as six different conceptions, categorized into two larger groups – reproductive or lower level conception and constructivist or higher-level conception. Regarding "approach to learning" suggested by Marton (1983) and modified by Lee et al. (2008) for science context, students' approaches to learning science are divided into two types of approaches, surface approach, and deep approach. Together, these COLS and ALS concepts, have gained evidence in quantitative and qualitative studies that students conceiving learning science as reproductive use the surface approach, while those conceiving learning science in higher level of conception, use the deep approach in learning science (Crawford, Gordon, Nicholas & Prosser, 1998; Marton et al., 1993; Lee et al.,

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2008). A higher hierarchy of approaches that students use, the higher confidence that students had to be successful in science instruction, and vice versa for the lower one (Chin & Brown, 2000; Ellis, Goodyear, Calvo & Prosser, 2008).

However, Koballa, Graber, Coleman, and Kemp (2000), Tsai (2004) and Tavakol and Dennick (2010) claimed that there might be a possibility of a student having more than one conception of learning in different contexts. In the later research, Lin and Tsai (2008) found that students also have multiple conceptions and mixed approaches to learning. A few studies in science education indicated these multiple and mixed issues. Most of the previous studies developed a model by especially independent variables that are COLS components and are not associated with other COLS components (e.g., Chiou, Liang & Tsai, 2012; Shen et al., 2016; Zheng et al., 2018). This research examines the inter-correlation of COLS, ALS, and self-efficacy in the form of the model, whereby one COLS component is associated with other COLS components as the assumption that students have multiple conceptions of learning science. As many have also mentioned that students' learning orientations are also influenced by culture in the form of school curriculum (e.g., Lee et al., 2008; Li, 2003), current research also has more insight on Indonesian upper-secondary school students, a population that has not much been explored previously, in science learning.

Besides culture and educational systems of a particular country influence students' learning orientation, gender is also a social factor that contributes to the diversity of students' learning orientation (Chiou et al., 2012; Philbin, Meier, Huffman & Boverie, 1995; Severiens & Dam, 1994). Females use more rote learning than males leading to the more frequent use of the surface approach in learning (Entwistle & McCune, 2004; Kolb, 1984; Severiens & Dam, 1994). However, there is limited research in examining the different paths practiced by females and males in science learning. Following testing the model of Indonesian students learning orientations based on COLS, ALS, and self-efficacy in full sample, this research conducts multi-group analysis to obtain more insight into the differences of model based on gender.

## Theoretical Framework

### *Conceptions of and Approaches to Learning Science (COLS and ALS)*

Some may be questioning the distinction between the meaning of 'concept' and 'conception.' Enwistle and Peterson (2004) explain the differences and correlations between the two terms. They explain that concept is a term that is used for categorization of particular objects and/or behavior making them possible to be widely recognized, while conception is the response of individual based on different experiences to the concept. Different experiences of learning may lead to different perspectives of learning that students conceive.

In addition to the research on conceptions, the most notable researcher is also considered as the pioneer of research in conceptions of learning is Säljö (1979). Through interviewing adults about how they view learning, Säljö identified five conceptions attached to learning; from learning as an effort to increase knowledge, to learning as an effort to better understand the reality of the world. Others have expanded Säljö's research and identified quite different types of conceptions but similar in meaning and hierarchy (Marton et al., 1993; Marshal, Summer & Woolnough, 1999), but no research accounted for students' conceptions of learning science until the phenomenological research conducted by Tsai (2004) and expended by Lee et al. (2008) in the form of quantitative research.

Based on the findings of Tsai (2004) and Lee et al. (2008), students conceive learning science as six different conceptions; learning science as memorizing, testing, calculating and practicing, to increase knowledge, applying and learning science as an effort to understand and see things in a new way. Those six conceptions are categorized into two hierarchical trends. The first three mentioned conceptions are categorized into a lower hierarchy or reproductive conception whereby students with these conceptions are prone to see learning in quantitative ways, such as the only acquisition of knowledge and scores (Biggs, 1994). To the contrary, the last three mentioned conceptions are placed in the higher hierarchy or called as constructivist conceptions that means seeing learning science in the qualitative perspective. Students with constructivist conceptions are prone to have a higher desire to understand better the science concepts being learned (Biggs, 1994). A desirable attitude to better understand science is one of the affective aspects indicating a scientifically literate person (Bybee, 1997).

Many studies have indicated that students' conceptions of learning are directly related to the way how they process academic tasks leading to the outcome of their learning (Allan, 2003; Chin & Brown, 2000; Purdie, Hattie & Douglas, 1996). Tsai et al. (2011) have pointed out that students with higher conceptions of learning (science) use a more sophisticated way of learning and vice versa for those that conceive learning as reproductive. Two distinctions of approaches in learning are proposed by many researchers (e.g., Biggs, 1994; Chin & Brown, 2000; Kolb, 1984; Lee et al., 2008; Marton, 1983) and known as surface and deep approach. Deep approach or some also called as 'meaningful' learning is mainly driven by intrinsic motivation and or sophisticated affective commitment that resulted from previous experiences in learning science. To the contrary, the surface approach is driven by extrinsic motivation. Chin and Brown (2000) and Lee et al. (2008) indicated that surface and deep approaches are constructed by two components; student's motive and the strategies, whereby motive is an impacted strategy.

In the later research of conceptions and approaches in learning science, many have found that students with reproductive conceptions of learning science use the surface approach and mix it with the deep approach. Also, it applies to the constructivist conceptions. Lee at al. (2008) found that students that conceive learning science as testing used surface and deep approach, also they found that students that conceive leaning science as applying are driven by surface and deep motive. Later studies conducted by Zheng et al. (2018) and Shen et al. (2016) suggested similar findings. Those previous studies were mostly conducted on the Chinese/ Taiwanese samples and used structural equation modeling to find the significant path. Those previous studies did not explain the reason students with higher conceptions of learning science use deep approach and the surface approach as well. The findings probed to what has been mentioned by Koballa et al. (2000), Tsai (2004) and Tavakol & Dennick (2010) about the indications that students have more than one conception of learning to lead to the use of more than one approach to learning.

The possibility that students have multiple conceptions of learning, later also supported by Lin and Tsai (2008) in the research of exploring Taiwanese undergraduate students via interviews about their conceptions of learning management and proposed 'tree of conceptions of learning' to map the diverse multiple conceptions of learning by students. One of their findings is that most of the students have mixed conceptions between reproductive and constructivist, reproductive and reproductive and also constructivist and constructivist. These mixed conceptions may lead to the mix and magnitude of the approaches applied by students. Researchers have argued that students may conceive learning that departs from or combines memorizing with other naïve or higher conceptions (Lin, Liang & Tsai, 2015; Lin & Tsai, 2008; Marton, Wen & Wong, 2005). As known in science subjects there are many facts, formulas, and symbols that must be memorized by students to acquire a better understanding of the content. Regarding acquiring a better understanding of content through memorization, many have termed it not 'rote learning' but 'mindful memorization' (Anderson & Schönborn, 2008; Kember, 2000; Marton, Watkins & Tang, 1997). By having multiple conceptions of learning at once, students also may have several motives and strategies of learning, given that conceptions of learning are highly correlated to approaches to learning.

Yet, to date, the studies of inter-correlation between students' conceptions of and approaches to learning science proposed in the form of path analysis and tested using statistical analysis approach did not consider the multiple conceptions had by students. This research reveals the existence of multiple conceptions of learning science leading to the mixed approaches to learning science via generating structural equation modeling. Previous studies on exploring conceptions of and approaches to learning science had been conducted by using data from mostly Taiwan and mainland China. This research used the data of Indonesian high-school students. This also is considered as an effort to observe the impact of culture on the path in the model, given that cultural backgrounds influence students' conceptions of and approaches to learning science (Lee et al., 2008; Li, 2003; Purdie et al., 1996; Tweed & Lehman, 2002). As mentioned earlier that students' conceptions of and approaches to learning science correlate with their learning performances, some studies (e.g., Shen et al., 2016; Zheng et al., 2018) have found that students' conceptions and approaches influence their science self-efficacy. More detailed explanations are provided below.

### *Self-efficacy in Science Learning*

Self-efficacy is the term used as the core of Albert Bandura's social cognitive theory. Bandura (1977) explains self-efficacy as a person's judgment of their ability on if they can excel at a particular task or not. In the context of science learning, self-efficacy explains how students judge their ability to complete the science-related task to achieve desirable science achievements (Robnett, Chemers & Zurbriggen, 2015; Zeldin, Britner & Pajares, 2008). As Bandura (1997) states that self-efficacy positively influences one's performance in a particular task. In the field of science education, many have supported this with different sample properties and levels from informal to formal science setting and from primary to college level students (e.g., Andrew, 1998; Robnett et

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al., 2015; Zheng et al., 2018).

In line with conceptions of learning science established based on students' previous experiences, their self-efficacy is also constructed based on students' experience (Bandura, 1997). Notable experiences that strengthen students' science self-efficacy are mastery and vicarious experiences (Bandura, 1997; Zeldin et al., 2008). Additionally, Bandura (1997) emphasizes that mastery experience is the most influential factor that can elevate one's self-efficacy. Another thing that correlates to student's science self-efficacy is self-regulation ability (Bouffard-Bouchard, Parent & Larivee, 1991; Schunk & Zimmerman, 2007). Self-regulation ability is a metacognitive skill whereby students engage in the act of managing and regulating their learning. Better strategy and better management of learning lead to the elevation of completing a science-related task (Chin & Brown, 2000). In addition, Glynn, Brickman, Armstrong, and Taasoobshirazi (2011) argue that science self-efficacy is also part of students' motivation towards learning science. They also claim that self-efficacy shares variance with other motivation constructs; intrinsic motivation, extrinsic motivation and self-determination, and intrinsic motivation has the highest explained variance of self-efficacy compared to others.

Based on theoretical background, some researchers have also proposed models with the assumptions that student's conceptions of and approaches to learning science influence students' self-efficacy in learning science (e.g., Phan, 2007; Shen et al., 2016; Tsai et al., 2011; Zheng et al., 2018). According to Phan (2007) and Tsai et al. (2011), students with constructivist conceptions are prone to positively influence science self-efficacy, and vice versa for the reproductive one. Phen also reported that students that use deep approaches (motive and strategy) have a higher level of self-efficacy. Shen et al. (2016) conducted research on uncovering students' conceptions of, approaches to and self-efficacy in learning earth science and conducted structural equation modeling found that only deep strategy and conceptions of learning earth science as applying have a significantly direct effect on students' self-efficacy. While the latest research conducted by Zheng et al. (2018) on primary students found that only deep approaches have a direct impact on students' self-efficacy in lower and higher levels of self-efficacy. Most of the conducted studies examining conceptions and approaches as the variables that can predict self-efficacy were used mostly samples from Confucian culture. Given that path analysis and students' learning orientations to science vary based on culture, gender and other social factors (Severiens & Dam, 1997), this research generates a model of those two variables in predicting self-efficacy in science learning by using Indonesian upper-secondary schools' data. As the current notion of science education is bringing equity in science, gender issues have also brought to the current research the emphasis on different pathways taken by different genders. More details about gender differences in learning orientations are described below.

### *Gender Differences in Learning Orientations*

Of the inter-correlations between conceptions of, approaches to and self-efficacy in learning science, Baeten, Kyndt, Struyven and Dochy (2010) claim that it can predict students' learning orientations. In addition, Severiens & Dam (1994, 1997) argue that learning orientations vary based on contextual factors, such as subject, country, and gender. Many studies have been conducted to explore more gender differences in learning orientations; some found significant differences (e.g., Chiou et al., 2012; Severiens & Dam, 1998) and some said gender differences found insignificant (e.g., Miller, Finley & McKinley, 1990; Wilson, Smart & Watson, 1996). Additionally, those conducted research were conducted in mostly mathematics and languages, and a few on science subjects. This research reveals gender differences in learning orientation in the science learning context.

Based on the categorization of learning orientation proposed by Entwistle and Ramsden (1983), there are four types of learning orientations mostly driven by different motivation towards learning; extrinsic or intrinsic. The first type of orientation is called meaning orientation driven by internal motivation. Students' with this orientation frequently use deep strategies such as comprehension study, relating one idea to another idea as well as using much evidence. Meaning orientation may be more preferred by men than women, as what Kolb (1984) claims that men are prone to use more abstract conceptualization mode when learning than women do. The second type of learning orientation is reproducing orientation, the opposite of meaning orientation. Reproducing orientation is driven by external motivation featured with the anxiety of failing in a course leading to the use of rote memorization and only focuses on the requirement to pass on the course. Entwistle (2013) pointed out that women are prone to have this learning orientation due to that they have more concerns about learning.

The last two orientations are proposed and explained in the later studies (Enwistle & McCune, 2004; Tait & Enwistle, 1996). As the third type, achieving orientation is driven by external motivation but uses deep approaches and organized learning. The last orientation is non-academic orientation. This orientation refers to the low level of motivation in learning and using disorganized methods of learning. Tait and Entwistle (1996) called this orientation an apathetic approach. The research of gender in the last two orientations is limited and unclear, especially in the context of school science. This research also reveals the existence of these last two orientations and the first orientations featured with the examination of gender differences.

*Hypothesized Model for the Inter-correlations of Conceptions of, Approaches to and Self-efficacy in Learning Science*

Through the assumption that students have more than one conception of learning and mixed motives and strategies in learning (Lin, Liang & Tsai, 2015; Lin & Tsai, 2008; Marton et al., 2005), this research modifies the previous conducted studies that have not considered generating these issues in their model (e.g. Shen et al., 2016; Zheng et al., 2018). Due to approaches to learning science also correlated to science self-efficacy that have been described above, self-efficacy is also included in the hypothesized model depicted in Figure 1. The multiple conceptions of learning science are assigned by paths departing from lower conceptions to higher ones. As several studies found that conceptions of learning science as applying and understanding have direct effect to self-efficacy (Lin, Liang & Tsai, 2015; Shen et al., 2016); this research also addresses this issue by connecting the path from applying to self-efficacy. Ultimately, as gender has an impact in determining students' learning orientation, examining the model based on multi-group of gender via structural equation modeling is also one of the objectives of this research. The following are the research hypotheses that are used to build the model:

H.1. Students significantly have multiple conceptions of learning science.

H.2.1. Students with reproductive conceptions of learning science use the mix motives and strategies to learn science.

H.2.2. Students with constructivist conceptions of learning science use the mix motives and strategies to learn science.

H.3. Students' approaches to learning sciences mediate students' conceptions of learning science and science self-efficacy.

H.4. Conceptions of learning science as applying and understanding have direct effect on science self-efficacy.

H.5. The paths on the accepted model are different based on gender.

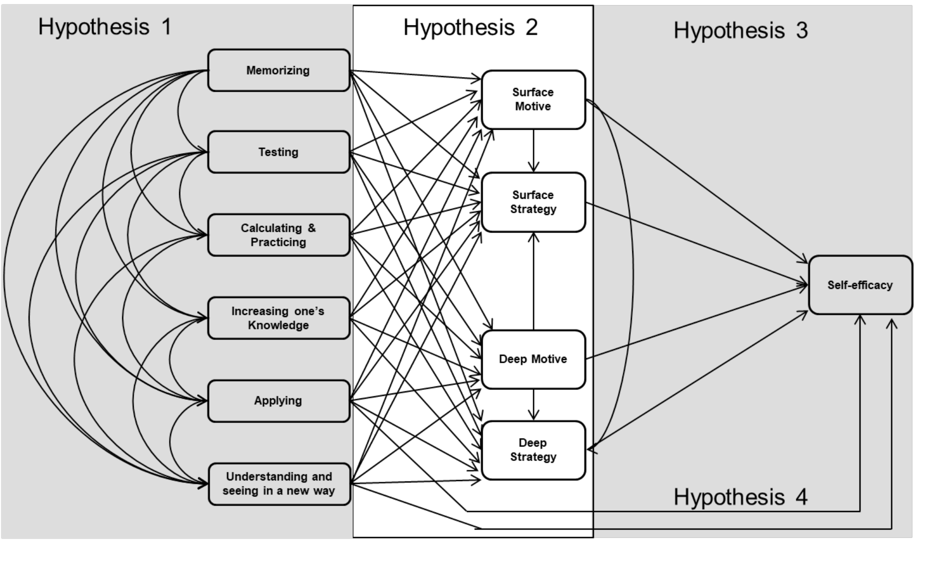


**Figure 1. Hypothesized model for the inter-correlation between conceptions of, approaches to and self-efficacy in science learning.**

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**Methodology of Research**

*General Background*

This research used a quantitative method featured with the implementation of structural equation modeling in finding out the research questions. Three instruments were used to reveal Indonesian students' science learning orientations. This research is part of the continuous project entitled "Exploring Indonesian Middle School Students' Learning Orientations in Science" which has a goal on finding out Indonesian students' science learning orientation, and thus the data from one instrument that was already used in the previous research (Rachmatullah, Diana & Ha, 2017). The survey for this research was conducted from March to September 2017.

*Participants and Research's Design*

Data were gathered from five public Indonesian upper-secondary schools in the west part of Java Island. A total of 600 students participated in the survey, and those students were in their second semester (April-May 2017) of first (44%) and second grades (56%). The third grader did not participate in the survey because of school's regulation issue that they are prohibited to involve in any act of intervention and survey as an effort to make them focus on the national graduation exam. The number of sample size was determined using the G-power analysis for $\chi^2$ for the goodness-of-fit test (Faul, Erdfelder, Buchner & Lang, 2009), given the SEM uses the function of $\chi^2$. Based on the G-power analysis with the effect size higher than 0.3, α err prob .05, power (1-β err prob) .95 and one-degree freedom, the minimum sample size is 145. Thus, 600 samples should be considered more than sufficient to conduct the study. Demographically, regarding gender, 63% of the participants were indicated as female, and the remaining students (37%) were males. Moreover, 95% of the students were affiliated with Islam as their religion.

*Instruments*

*Conceptions of learning science (COLS).* An instrument developed by Lee et al. (2008) was carefully translated into Indonesian by two science education experts that are fluent in English and Indonesian. The translated version was used as the measure to examine Indonesian students' conceptions of learning science. The instrument consisted of 31 items measuring six dimensions of conceptions in learning science; memorizing, testing, calculating and practicing, increasing knowledge, applying and understanding-seeing in a new way. Memorizing, calculating and practicing, and increasing knowledge were composed of five items, testing and understanding were composed of six items, and only applying had four items. The instrument was based on the phenomenological research conducted by Tsai (2004). The instrument was 5-point Likert scale. The COLS data used in this research was from the previous research (Rachmatullah et al., 2017). The psychometric properties of the instrument are depicted in Table 1.

**Table 1. Psychometric properties of the used variables [All mean-square – MNSQ values met the cut-off based on Boone, Staver and Yale (2014) which is between 0.50-1.50].**

| Variable | α | Range of α if item deleted | Infit MNSQ | Outfit MNSQ | Rasch Person Reliability | Rasch Item Reliability |
|---|---|---|---|---|---|---|
| Memorizing (M) | .68 | .59 ~ .64 | 0.75 ~ 1.16 | 0.73 ~ 1.17 | .65 | .81 |
| Testing (T) | .68 | .59 ~ .69 | 0.70 ~ 1.40 | 0.71 ~ 1.36 | .68 | 1.00 |
| Calculating and practicing (CP) | .81 | .76 ~ .80 | 0.82 ~ 1.41 | 0.80 ~ 1.37 | .76 | .94 |
| Increasing one's knowledge (IK) | .78 | .71 ~ .78 | 0.77 ~ 1.21 | 0.71 ~ 1.25 | .73 | .99 |
| Applying (A) | .77 | .70 ~ .77 | 0.76 ~ 1.31 | 0.73 ~ 1.33 | .70 | .94 |
| Understanding and seeing in new way (US) | .83 | .79 ~ .83 | 0.85 ~ 1.17 | 0.75 ~ 1.11 | .77 | .93 |
| Surface motive (SM) | .80 | .75 ~ .79 | 0.77 ~ 1.19 | 0.80 ~ 1.16 | .71 | .97 |

| Variable | α | Range of α if item deleted | Infit MNSQ | Outfit MNSQ | Rasch Person Reliability | Rasch Item Reliability |
|---|---|---|---|---|---|---|
| Surface strategy (SS) | .71 | .62 ~ .73 | 0.75 ~ 1.49 | 0.76 ~ 1.46 | .70 | .99 |
| Deep motive (DM) | .85 | .81 ~ .85 | 0.61 ~ 1.46 | 0.62 ~ 1.44 | .83 | .99 |
| Deep strategy (DS) | .82 | .76 ~ .82 | 0.66 ~ 1.46 | 0.65 ~ 1.48 | .80 | .98 |
| Self-efficacy (SE) | .85 | .82 ~ .84 | 0.84 ~ 1.37 | 0.80 ~ 1.34 | .81 | .96 |

*Approaches to learning science (ALS).* In terms of examining students' approaches to learning science, an instrument that also was developed by Lee et al. (2008) was translated and used in this research. The instrument was adapted from the instrument developed by Kember, Biggs and Leung (2004). ALS instrument consisted of four constructs; surface motive, surface strategy, deep motive and deep strategies. A total of 24 items measured those four constructs which each construct was consisted of five, five, eight and six items respectively. The instrument was 5-point Likert scale. The psychometric properties of the instrument are depicted in the Table 1.

*Science self-efficacy.* This research used the science self-efficacy construct developed by Glynn et al. (2011) as part of the widely used Science Motivation Questionnaire (SMQ). The self-efficacy construct was composed of five items. The reason why it was used in this research is because the instrument has been validated by students in science and non-science majors. The validity issue and stability of the instrument are well-trusted (Glynn, Taasoob-shirazi & Brickman, 2009; Glynn et al., 2011). The instrument was 5-point Likert scale. The psychometric properties of the instrument are depicted in the Table 1.

### *Data Analyses*

Prior to testing the hypothesized model, Rasch analyses through Winstep 4.0.0 were conducted to validate the instrument as well as to convert the obtained categorical data into interval data that are more acceptable for statistical analyses especially a parametric one. All the further statistics of this research used the outcome from the Rasch analysis; person measure (logit). Following, Pearson's correlation test was conducted to identify the direction and magnitude that the used variables had correlated with each other. Pathway analysis via AMOS was conducted to test the hypothesized model. Model fit was evaluated using the cut-off suggested by Hu and Bentler (1999), and Schumacker and Lomax (2004). They suggested that the good model is the model that has adjusted goodness of fit index (AGFI) and normed fit index (NFI) more than .90, Tucker-Lewis index (TLI) and comparative fit index (CFI) more than .95, standardized root mean square residual (SRMR) less than .08 and the root-mean-square error of approximation (RMSEA) below .06. Then, evaluating if the model is significantly different in terms of gender or not was taken through the interpretation of the chi-square results (CMIN) whereby p-value $< 0.05$ is considered that the model is different.

## Results of Research

### *Descriptive Statistics and Pearson's Correlation Results*

The averages and Pearson's correlation results are depicted in the Table 2. Due to the means they were computed from Rasch analysis and now had the similar unit – logit – make it comparable. Based on a direct comparison of the obtained means, this research found that the highest mean for conceptions of learning science was IK ($M$ = 3.05; SD = 2.14) which indicated that most of the Indonesian students conceived learning science as increasing their knowledge. In terms of approaches to learning, surface motive ($M$ = 2.32; SD = 1.97) found as having the highest mean followed by deep strategy ($M$ = 1.49; SD = 1.99).

In terms of the results from Pearson's correlation tests, this research found that most of the used variables correlated significantly to self-efficacy with deep strategy ($r$ = .43) and deep motive ($r$ = .42) having the highest coefficient correlation, respectively. However, testing ($r$ = –.03) was found insignificantly correlated to the self-efficacy. Not only not correlated significantly to self-efficacy, but testing was also found insignificantly correlated to most of the used variables except to reproductive conceptions – memorizing ($r$ = .28) and calculating and practicing ($r$ = .19), and surface strategy ($r$ = .39). This research also found that surface strategy negatively correlated to all variables except for testing, memorizing ($r$ = .09) and surface motive ($r$ = .26).

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**Table 2. Average of person measures (logit) and correlation coefficients among variables.**

| Variable | Mean (SD) | Correlation | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | M | T | CP | IK | A | US | SM | SS | DM | DS |
| M | 1.76 (1.56) | – | | | | | | | | | |
| T | –0.41 (1.14) | .28** | – | | | | | | | | |
| CP | 2.46 (2.22) | .39** | .19** | – | | | | | | | |
| IK | 3.05 (2.14) | .38** | .05 | .29** | – | | | | | | |
| A | 2.60 (2.51) | .38** | .05 | .42** | .55** | – | | | | | |
| US | 2.89 (2.28) | .42** | .04 | .37** | .52** | .63** | – | | | | |
| SM | 2.32 (1.97) | .26** | –.03 | .26** | .32** | .26** | .27** | – | | | |
| SS | –0.55 (1.27) | .09* | .39** | –.05 | –.08* | –.12** | –.09* | .26** | – | | |
| DM | 1.28 (1.69) | .41** | .02 | .35** | .42** | .49** | .58** | .31** | –.12** | – | |
| DS | 1.49 (1.99) | .35** | .04 | .34** | .43** | .49** | .56** | .18** | –.08 | .71** | – |
| SE | 2.72 (2.76) | .27** | –.03 | .27** | .25** | .37** | .39** | .26** | –.19** | .42** | .43** |

*** p < .01, * p < .05, no mark p > .05*

*Structural Equation Modelling (SEM) and Multi-group Analysis Results*

*Structural equation modelling of the correlation between Indonesian students' COLS, ALS and science self-efficacy.* Exploring the path correlations among Indonesian upper-secondary school students' conceptions of, approaches to and self-efficacy in learning science were achieved via conducting structural equation modeling (SEM). First, the hypothesized model displayed in the Figure 1 was tested and the insignificant (p > .05) paths were deleted. Finally, the model with acceptable fit indices was found and displayed in the Figure 2 featured with standardized regression coefficients (β). As depicted in the Table 3, the fit indices of the model in Figure 2 were $\chi^2/df = 1.74$, SRMR = .036, GFI = .989, AGFI = .966, IFI = .993, TLI = .980, CFI = .993 and RMSEA = .035 (CI 90% = .014 ~ .054).

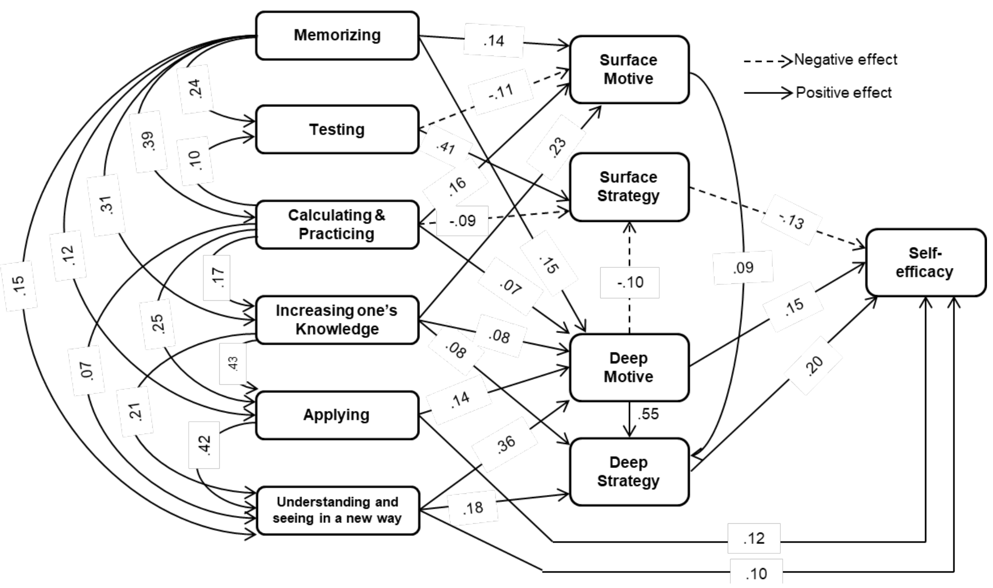


**Figure 2. Pathway analysis results featured with standardized regression coefficients for all sample.**

*Note: the paths shown are significant at p < .05, not significant paths were deleted*

To examine the first hypothesis that students have more than one conception of learning science has been tested through correlating one conception to other conceptions. Based on the accepted model depicted in Figure 2, learning science as memorizing was found positively influencing other conceptions in lower (β = .24-.39) and higher (β = .12 ~ .31) level conceptions. In addition, learning science as calculating and practicing was also found having a direct effect on all higher-level conceptions (β = .07-.25). This research also found that learning science as testing was influenced by other two reproductive conceptions, memorizing (β = .24) and calculating and practicing (β = .10).

Students that conceived learning science as memorizing (β = .14), calculating and practicing (β = .16), and increasing knowledge (β = .23) positively used surface motive, while students with conceptions of learning science as testing negatively used surface motive (β = -.11). Students triggered to use surface strategy in learning science were mostly those that conceived learning science as testing (β = .41). In terms of deep motive, most of the conceptions of learning science, except as testing, were found directly triggering deep motive (β = .07 ~ .36). The deep strategy was found directly used by students that conceive learning science as increasing knowledge (β = .08) and understanding (β = .18), and students with deep motive (β = .55). Surprisingly students with surface motive significantly use deep strategy (β = .09) and did not use surface strategy. Only deep approaches triggered the advanced level of science self-efficacy (motive β = .17 and strategy β = .22). To the contrary, surface strategy (β = -.13) triggered lowering science self-efficacy. The fourth hypothesis is indicating that students' conceiving learning science as applying and understanding significantly had a direct effect on their science self-efficacy (β = .12 and β = .10, respectively).

**Table 3. Fit indexes of the path models**

| | $\chi2$/df | SRMR | GFI | AGFI | IFI | TLI | CFI | RMSEA (CI90) |
|---|---|---|---|---|---|---|---|---|
| Path model with full sample (hypothesized model) | 1.74 | .036 | .989 | .966 | .993 | .980 | .993 | .035 (.014 ~ .054) |
| Multi-group analysis | | | | | | | | |
| Unconstraint | 1.70 | .048 | .978 | .935 | .986 | .963 | .985 | .034 (.020 ~ .047) |
| Weight constraint | 1.76 | .073 | .960 | .931 | .973 | .960 | .972 | .036 (.026 ~ .045) |
| Model comparison | 1.83 (p < .01) | | | | | | | |

*Multi-group analysis-based gender results.* To explore if the obtained acceptable model depicted in Figure 2 differs based on gender or not, a multi-group analysis-based gender was conducted, and fit indices were obtained. Based on the fit indices shown in the Table 3, all of the indices showed acceptable value for a good model. Based on the model comparison resulted through chi-square test, this research found that the model was significantly different based on gender ($\chi^2$/df = 1.83, p < .01). The comparison of significant paths between both genders are shown in the Figure 3.

Based on Figure 3, several paths were significantly different between male and female students. Regarding conceptions of learning science, the insignificant path was found between "memorizing" and "understanding" in males (p > .05) while it was significant in females (β = .18, p < .05). A similar finding was also found in the path from "calculating and practicing" to "testing" whereby insignificant in male (p > .05) but significant in female (β = .10, p < .05). In the paths from conceptions of learning science to approaches, male students that conceived learning science as memorizing only use deep motive (β = .15) while female students that conceived it are prone to use mixed motives (β = .14 and β = .17, respectively for surface and deep motive). In terms of learning science as testing, male students that conceived this are prone to use surface strategy (β = .48) and did female students too (β = .35) but with negative surface motive (β = –.15). Male students that viewed learning science as calculating, and practicing used mixed motives (β = .16 and β = .09, respectively for surface and deep motive) while females that conceived this only use surface motive (β = .16). In contrast to learning science as calculating and practicing, in the learning science as increasing knowledge male students are prone to use only surface motive (β = .21) while females are likely to use mixed motive (β = .28 and β = .13, respectively for surface and deep motive). Indonesian male students that conceived learning science as applying are prone to use deep motive (β = .27), while female students with this conception indirectly

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use this motive through transforming their conception to 'understanding and seeing in a new way' (β = .36). Both male and female students that conceived learning science as understanding and seeing in a new way' were likely to use only deep approaches (Male β = .35, β = .21; Female β = .34, β = .17, respectively for deep motive and strategy).

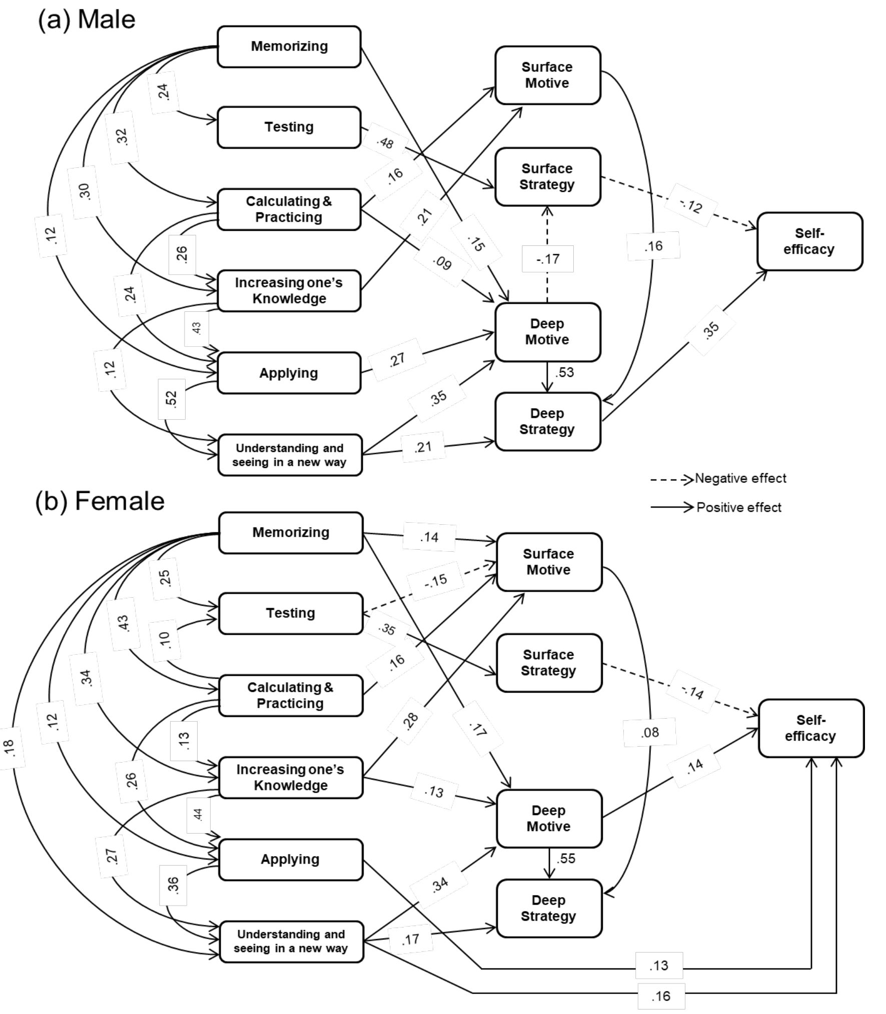


**Figure 3. Pathway analysis results featured with standardized regression coefficients for multi-group analyses- based gender, (a) males' pathway and (b) females' pathway.**

*Note: the paths shown are mostly significant at p < .05, insignificant paths were deleted*

Regarding the issue of mixed approaches, this research found that male and female students with deep motive and surface motive in learning science significantly used deep strategy (Male β = .16, β = .53; Female β = .08, β = .55, respectively for surface and deep motive). Assuming that students' conceptions of learning science correlated with their approaches to learning science that later exerted as their science self-efficacy, this research found different paths in males and females that influence their science self-efficacy. In males, only the uses of learning strategies that directly influence their science self-efficacy, whereby those that used deep strategy positively influenced their science self-efficacy (β = .35) while those that used surface strategy negatively affected their science self-efficacy (β = –.12). In contrast, female students' science self-efficacy was directly impacted by deep motive (β = .14) and their conceptions of learning science as applying (β = .13) and understanding and seeing in a new way (β = .16).

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## Discussion

The purpose of this research was to examine Indonesian upper-secondary school students' learning orientation in science via generating structural equation modeling of conceptions of, approaches to and self-efficacy in learning science. This research also reveals the impact of gender on the accepted proposed model. Based on the findings, there were three important issues related to Indonesian upper-secondary school students' learning orientation; first, the use of memorization as the stepping point to facilitate gaining higher conceptions of learning, second, Indonesian students have multiple conceptions of learning science leading to the mixed motives and strategies used in learning science. Third, is that Indonesian male and female students have different science learning orientation. These three findings are discussed in more detail in the following two sections.

*Indonesian Upper-secondary School Students' Learning Orientation in Science*

Based on the findings projected as a graphical illustration in the Figure 2, Indonesian upper-secondary school students had multiple conceptions of learning science as shown by the connecting paths from one conception to other conceptions of learning science. This multiple conceptions of learning science of Indonesian upper-secondary school students may be caused by different teaching methods used by science teachers from primary school through their upper-secondary school level. Different teaching methods used in science classrooms may lead to different learning experiences that students acquired. As stated previously by Enwistle and Peterson (2004) in the introduction part of this study that student's conceptions of learning are gained by their learning experiences. The changes in Indonesian general curriculum may also indirectly influence students' conceptions of learning science, because most of the teaching methods that teacher used in the classrooms are the methods suggested in the general curriculum. In the last 10 years in Indonesia's educational system, including science, the curriculum has changed and been revised three times with markedly different outcomes, especially in the goal of learning. It has impacted the way teachers have taught science in class from primary to upper-secondary school.

Interestingly, the lowest level of conception – learning science as memorizing has a positive direct effect on other conceptions in reproductive and constructivist conceptions. Johnstone (2000) stated that in science there are many explanations, symbols, and formulas that inevitably emerge in the learning process and are unavoidable for students in the learning process. Students may inevitably have these kinds of conceptions of learning science. Yet, it could not be merely considered that students have to use rote learning in science. This also corresponds to the next path after memorizing, whether it is to other reproductive conceptions or constructivist conceptions. When students have a combination of conceptions of learning science with other reproductive conceptions such as "memorizing-testing", "memorizing-calculating/practicing", or "memorizing-calculating/practicing-testing", they use surface strategy with surface motive such as rote learning. This type of path would instill students with a learning orientation in "methodical" type that only focuses on doing well in tests (Komarraju, Karau, Schmeck & Avdic, 2011). In contrast, when students conceive learning science as a combination of memorizing and other constructivist conceptions, this leads to the perception of students that memorize as the basis for them to increase knowledge, to apply what they have memorized and to better understand science. This kind of multiple conceptions refers to what Anderson and Schönborn (2008) and Mayer (2002) termed as "mindful memorization" that is contrasted from rote learning. Memorizing also plays a role as building students' prior knowledge that is an essential starting point for students to engage in more advanced learning and deeper understanding (Pals, Tolboom, Suhre & van Geert, 2017). Anderson and Schönborn and Mayer also argued that mindful memorization is related to memorizing facts and definitions as well as recalling and repeating it as the evidence of using a higher level of memory. This may also be referred to as practicing activities in learning science, whereby in practicing activities students engage in the act of recalling several times of facts or motivation being learned. Figure 2 also shows that learning science as calculating, and practicing had a positive impact to the three constructivist conceptions. Through leading to the higher conceptions of learning science, students become closer to use deep approach. As what shown in the Figure 2, all the constructivist conceptions, "memorizing" and "calculating practicing" have positive effects on deep motive.

Regarding students' approaches to learning science departing from conceptions of learning science, this research found that students that conceived learning science as memorizing, calculating and practicing, and

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increasing knowledge use have mixed motives but not mixed strategies. This answered the second hypothesis of this research. Learning science as memorizing and calculating and practicing that have been explained above are correlated in promoting "mindful memorization". But the finding on increasing knowledge has supported the previous research conducted by Lee et al. (2008) with the explanation that conceiving learning science as increasing knowledge may be transitional conceptions placed between reproductive and constructivist conceptions and ambiguous in terms of increasing knowledge.

Regarding approaches to learning science, it was found based on Figure 2 surface, and deep motive significantly and positively trigger the use of deep strategy. The positive and high impact of deep motive to deep strategy is also supported by several previous findings and claims (e.g., Lee et al., 2008, Kember et al., 2004). But, interestingly instead of positively impacting the use of surface strategy, the surface motive was positively having a direct effect on deep strategy. This may lead to a sense that even though Indonesian upper-secondary school students only worrying their grade in science and concerning learning science due to merely for obtaining better grades and a job, but they use deep strategy to realize the motive. Tests and grades are intertwined in Indonesian science classrooms and considered as the important parameter of success in schooling, as it remains the national examination that evaluates students in the last semester of every level of schooling (second semester of sixth, ninth and twelfth grades). Consequently, it is inevitable for Indonesian students to have a surface motive in learning science. With this finding in the use of deep strategy by students that use surface motive, it suggests that Indonesian students may have achieving orientation as their type of learning orientation. As what Biggs (1978, 1994) explained that achieving orientation is the type of learning orientation that is motivated by obtaining excellence in a test via the systematic approach of learning. This systematic approach includes better organization of studying such as scheduling study periods.

Ultimately, as the last destination of the paths, science self-efficacy was directly affected by deep motive, deep strategy, learning science as applying and learning science as understanding and seeing in a new way. As in the introduction part has been described self-efficacy is known as one of the significant predictors of students' being successful in learning science (Robnett et al., 2015; Zeldin et al., 2008). This research findings have suggested that learning science through applying the facts and understanding it can directly influence Indonesian students' self-efficacy. This finding is also supported by several previous studies such as a research conducted by Lin et al. (2015) and Shen et al. (2016) that found the same findings via other samples. Regarding deep approach, deep strategy has higher impact than deep motive on self-efficacy. This may lead to the sense that students with better strategy in learning science have higher self-efficacy than those that only have high motive. Because, as what Bouffard-Bouchard et al., (1991) argue that students with a well-managed learning strategy are prone to engage in and improve their self-regulation activity that nurtures more positive variances to self-efficacy than only motive. However, these discussions of findings are limited to only Indonesian upper-secondary school students in western Java Island. Because, as Lee et al. (2008) that conceptions of, approaches to and self-efficacy differ based on culture, given that Indonesia is a multicultural society further studies from other cultural backgrounds in other parts of Indonesia are needed.

*Gender Differences in Science Learning Orientation*

The findings of this research reveal the existence of gender difference in the model of inter-correlation between Indonesian upper-secondary school students' conceptions of, approaches to and self-efficacy in learning science. Given the research on Indonesian students' learning orientation and style, especially in science subjects, based on gender is very limited, the discussions of the findings will be cautiously considered about other previous studies in gender differences in learning orientations.

Concerning the conceptions of learning science, this research found that Indonesian female students have more memorization as the base of multiple conceptions of learning science. It is shown in the Figure 3 that the path departing from memorization had one path more than in the male model, and the path is from memorization to understanding. This may lead to a sense that Indonesian female students are likely to use more memorizations when learning science than Indonesian male students. This may be caused by the impact of preferable science subjects, given that Lee et al. (2008) argue that specific science subjects influence conceptions of learning science. As Miller, Blessing, and Schwartz (2006) and Rachmatullah et al. (2017) reported that females have more interest on biology and biology subject is a known need to memorize many learning contents leading to female more likely conceiving learning science as memorization.

Regarding paths from conceptions to approaches, based on the model it was found that there were more positive direct effects to deep motive in male's model, while in the female's model there were more conceptions that had direct effect on a surface motive. This may lead to a sense that Indonesian male students are more likely to be interested in learning science than Indonesian female students. Indonesian female students are more likely to be concerned about their grade in science than male students. Together, this sense and the finding that female students used more memorization in learning science than previously discussed lead into one type of learning orientation called "reproducing orientations". As Entwistle (2013) said that reproducing orientation is caused by the exaggeration use of memorization and feeling anxiety of obtaining a low score in learning or task and exam oriented. This research findings are also in line with the meta-analysis research conducted by Severiens and Dam (1998) that found females significantly have reproducing orientation in learning than males. Entwistle (2013) also explains that because of females have higher intention in obtaining higher grades and scores, they see and focus on every detail of contents also more focus on what teachers asked to do in the class.

Last, regarding science self-efficacy that has a direct positive influence on students' science learning outcomes; this research found that different genders have different paths in influencing their science self-efficacy. Females' science self-efficacy was directly affected by higher level conceptions of learning that are applying and understanding and seeing in a new way. These findings suggest that providing science learning environment that mostly connects the science facts, definitions and laws to the daily life contexts or apply to another situation that is not found in the textbooks. Or through learning that frequently connects the previously learned science concepts to the concepts to be learned. Thus, Indonesian female students would feel that they learn science in a meaningful way. This kind of feeling positively impacts their science self-efficacy. In contrast, only one way to motivate Indonesian male students to enhance their science self-efficacy, which is through promoting deep strategy to them. This can be viewed in the sense that Indonesian male students can have higher science self-efficacy when they already have used or implemented the method of relating learned science concept and to be learned concepts not just by the teachers, as what females students do. This is also in line with the concept of meaningful learning orientation proposed by Entwistle and Ramsden (1983) that also found that males are prone to have this orientation. Yet, further research on qualitative ways is needed to explore in more detail of this research findings.

## Conclusions

The purpose of this research was to examine Indonesian upper-secondary school students' learning orientation in science via generating structural equation modeling of conceptions of, approaches to and self-efficacy in learning science and seeking whether the model is significantly differed based gender or not. The current research generated an acceptable statistical model of the inter-correlation between COLS, ALS, and self-efficacy in science learning. Generally speaking, by making sense of the generated model the current research found that Indonesian upper-secondary school students tended to have multiple conceptions of learning science and were prone to have mixed approaches to learn science. Multiple conceptions and mixed approaches are the characteristics of students with achieving orientations. Most importantly, the current research found that conceiving learning science as memorizing was considered as the basis for the higher level of conceptions (constructivist conceptions). Regarding the gender issue, the current research found that the generated model was significantly differed based on the gender. There were three differences; the first one is Indonesian female students conceive learning science as more memorization than males. The second one, Indonesian female students use more surface motive in science learning than males do. Third, this research found that Indonesian female students' science self-efficacy was easily impacted by their higher level of conceptions – applying and understanding.

Even though the current study has successfully generated an acceptable model of inter-correlation between COLS, ALS, and self-efficacy and found that the model was significantly differed based on gender, doubts and limitations still exist especially when interpreting the results. Because the current research only interprets the results by making sense of it without any further exploration of what Indonesian students are thinking about learning science. Thus, we believe the importance of conducting a qualitative study to dig more Indonesian students learning orientation in science subjects. By conducting further research through

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qualitative method, it is expected that the un-interpreted results such as the negative path from testing to surface motive may be revealed and could be explained more.

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