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Analysis of High School Students' Thinking Styles Towards Artificial Intelligence (AI)

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Abstract: The rapid development of artificial intelligence (AI) presents both challenges and opportunities for education, requiring students to develop critical and adaptive thinking skills to utilize it effectively. Students' thinking styles, defined as individual tendencies in processing information and solving problems, are a critical factor in assessing their ability to interact optimally with AI. One way to determine the characteristics of students is the style in which they think. Thinking styles can be divided into two types, namely convergent and divergent. This study aims to analyze the correlation between thinking styles and the gender of 11th-grade students at a senior high school in the city of Yogyakarta. The sample in this study included 102 students. The instrument used was a closed-thinking style questionnaire. The data analysis technique used are Z Test and Chi-Square Test. The results of the study show that the thinking style of the male students are more divergent, meanwhile the female students are more convergent. The Phi value is 0.269 and a significance (P Value) is 0.007 it showed that there is a correlation between thinking style and the gender of students. Results of this study reflect that there is a great impact of gender to thinking styles.

Keywords: Artificial intelligence; Gender; Thinking styles.

Introduction

The rapid development of artificial intelligence (AI) has presented both challenges and opportunities in education. While AI can accelerate the learning process and present material in a more adaptive and personalized manner, it also requires students to develop critical and adaptive thinking skills to effectively utilize this technology (Nadya et al., 2025). Students' thinking styles, individual tendencies in processing information and solving problems, are important variables in assessing the extent to which students can interact optimally with AI (Karnando & Slamet, 2020).

The newest result of the Program of International Student Assessment (PISA) conducted by the Organization for Economic Co-Operation and Development (OECD) in the literacy and science field showed unsatisfying results for Indonesia. The results from the 2018 PISA (Program for International Student Assessment) study, which is a study that focuses on reading literacy, mathematics, and natural science, show that Indonesia ranks 74th out of 79 countries. It showed that Indonesian students rank very low in the ability to understand complex information, theory, analysis, and problem solving, using tools, procedures and problem solving, and conducting investigations (Schleicher, 2018). This shows that Indonesian students have not been able to solve questions that require the ability to think divergently and creatively analyze questions and determine answers to these problems.

One way to find out the characteristics of students who have an influence on learning is the style of thinking. The importance of identifying and using knowledge in thinking styles in the cognitive domain in the learning process (Elliot, 2000). The teacher can expand teaching techniques as well as accommodate the characteristics of students (Santrock, 2009). Thinking style is the way individuals react to different situations. Thinking style is one way to describe individual differences. While the level and pattern of ability is influenced by heredity, the style of thinking influences the development of ability. Thinking style describes consistency in using cognitive processes. Thinking style includes stable behavior in the process of remembering, thinking and solving problems. Individuals actively process and modify incoming information, organize

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new knowledge and integrate it into memory structures (Saracho, 1997).

Divergent thinking (DT) and convergent thinking (CT), which are often associated with creativity, are desirable skills for student learning in all disciplines including mathematics education. These two terms (together, separately or only DT) sometimes are used to describe creativity as creativity is also linked with "original thought and divergence from the norm" (Bennevall, 2016; Cropley, 2006). DT is generally associated with multiple and alternatives outcomes while convergent one is linked with a single correct answer in responding to a posed question (Cropley, 2006). DT and CT are considered to be the two key important cognitive processes for creative thinking. DT as the ability to disengage from prevailing modes of thought and expression to generate novel ideas and solutions, while CT as the recruitment and interaction of different cognitive processes to find a common solution to a given problem (Japardi, 2018). Similar to the description of Japardi (2018), Cropley (2006) defines DT as one involves producing multiple or alternative answers from available information. By the contrast, he defines CT as being oriented toward deriving the single best (or correct) answer to a clearly defined question (Bingölbali & Bingölbali, 2020).

Convergent thinking style produces one correct answer and is a characteristic of the type of thinking required on conventional tests (Astra et al., 2022). Students who have a convergent thinking style prefer learning when faced with problems that have certain answers. When they face tasks and problems, they immediately try to find the right answers, find practical solutions to solving problems (Saracho, 1997). Divergent thinking, by contrast, involves producing multiple or alternative answers from available information. It requires making unexpected combinations, recognizing links among remote associates, transforming information into unexpected forms, and the like. Answers to the same question arrived at via divergent thinking may vary substantially from person to person, but be of equal value. They may never have existed before, and are often thus novel, unusual or surprising. Sometimes this is true merely in the experience of the person producing the variability in question, or for the particular setting, but it may also be true in an absolute sense (Cropley, 2006).

Research on student's understanding of chemistry, carried out in a variety of contexts, focused mainly on difficulties originating from the subject matter itself, such as the particulate nature of matter. in some cases, the effect of individual differences on such a fundamental theme was studied (Stamovlasis et al., 2012), which however needed further support and development. The study of individuals differences were important in science teaching, because it revealed the mental resources involved in learning specific domains and could relate them to persistent students' difficulties. For example, students' inability to make connections between macro and micro levels, which was seen as a core issue in chemistry education, might be due to their deficiency in formal reason and divergent thinking (Stamovlasis et al., 2015).

In mathematics and science, PISA 2018 suggests that gender differences are generally small. Boys outperformed girls just by five score points in mathematics, on average across OECD countries, and girls outperformed boys in science just by two score points (Schleicher, 2018). Previous studies have documented the relationship between brain thinking style and gender. Some researchers discovered that thinking style is positively correlated with gender (Zalizan et al., 2003). reported that male and female students who possessed different thinking and learning styles have different perspectives on the teaching style of teachers. These researchers claimed that one of the reasons for high dropout rate of male students from schools is female teachers' teaching styles are very much against the male students learning style. This would probably explain the difference of thinking styles between male and female students (Piaw, 2014). However, more research evidence needs to be gathered before any conclusion can be made. In view of the wide diversity of previous studies, this study was conducted to provide new evidence for the correlation between student's thinking styles and one personal factors, i.e. student's gender.

Method

This research was done in February 2023 was conducted at one of the public high schools in Yogyakarta. This research is descriptive research designed with a quantitative approach. This study employed a non-experimental design. Descriptive research aims to give the image of a population characteristic based on the collected data from samples. The method used in this research is survey research with cross sectional type. The population of this study were all students of class 11th at a public high school in Yogyakarta City, totaling 6 classes with a total of 180 students, while the sample used in this study was taken from 3 classes with a total of 102 students.

The data collection technique using questionnaire and interview, therefore the instrument used in this study are also a questionnaire and an interview sheet. The questionnaire contains 20 statements related to students' thinking styles with 10 statements referring to convergent thinking styles and 10 statements referring to divergent thinking styles. Three paper-pencil

psychological tests were used to gather data from the subjects of the study. The test is the thinking style test and was done in chemistry class. Before conducting the research, the researcher asked for the consent of the students to fill out a questionnaire.

The researcher also conducted interviews with chemistry teachers at school about student's thinking styles and the results of previous daily chemistry exams. The results of questionnaires of student answers are calculated based on the average scores of students. The data obtained analyzed using the SPSS application. The data analysis technique used phi coefficient test to see the correlation of student gender and thinking styles. The research data were tested statistically descriptive with a significant level (α) of 5% (0.05).

Result and Discussion

This section contains each research result that answers the research questions posed. This study included a questionnaire on student's thinking styles (divergent or convergent). After finding the student's thinking styles, we finding the correlation between student's thinking styles and student's gender. Based on the results of interviews with chemistry teachers in the schools that were the sample of this study, data has never been collected about student's thinking styles in chemistry class. The chemistry teacher stated that in chemistry subject colloid material was the easiest for students to understand, while analytical questions such as chemical reactions were material that was difficult for students to understand.

Even though research on student's thinking styles had never been conducted in that class, the teacher stated that the thinking styles of students in the average class led to a convergent thinking style, where students' attitudes during chemistry lessons could only focus on one problem and it was difficult to analyze High Order Thinking Styles (HOTS) questions. This is supported by data from previous daily exam results which show that students are still unable to solve questions that have a high level of cognitive levels.

Based on the results of interviews the learning model commonly used in chemistry subjects is problem-based learning (PBL), student-centered learning, and students find it difficult to focus on more than one material. The attitude of students during chemistry learning is cooperative, helping each other between friends. So based on the results of interviews with teachers, students' thinking styles in general are convergent. To strengthen this statement, data analysis was carried out from questionnaires that had been filled in by students, the data analysis was described by the chi square test.

Creative thinking and problem solving can be built into the instruction in many ways, and creative abilities have seen vital to the future success of students (Gregory et al., 2013). As mentioned above, the lack of learning experiences in the education of creativity inhibits student involvement in creating variability. Various aspects of the CT as a relationship with the previous concept, implementing an efficient strategy, and collect information considered when students complete problems. Aspects of CT must rely on authority, such as the perspective of the teacher or the correct answer. Students have little freedom to choose the system of representation they use in this case. Problems such as these give students new experiences related to CT than DT. Indeed, the majority of students said that the instructions from teachers are important because of the content they're working on is new and unfamiliar to them (Saleh, 2019). The frequency distribution of students based on gender presented in Table 1.

Table 1. Frequency distribution of students by gender

Number	Gender	Frequency	Percentage (%)
1	Female	61	59.8
2	Male	41	40.2
	Total	102	100

Based on the Table 1, it can be seen that of the 102 students, there were 61 female students with 59.8%, and there were 41 male students with 40.2%. Every individual has a different style of thinking. Differences in ability between male and female students are the factors studied because it is suspected that there is an influence of gender in terms of learning. Gender is a series of bound characteristics in which individuals born with different sexes acquire different identities and social roles. This gender difference makes people always think whether the way of thinking in learning will be different according to gender. So that gender differences can be said to be different roles, functions, and distinctive characteristics between male and female (Roue, 2011). The frequency distribution of students based on thinking styles presented in Table 2.

Table 2. Frequency Distribution of Students According to Thinking Styles

Number	Thinking Styles	Frequency	Percentage (%)
1	Convergent	68	66.7
2	Divergent	34	33.3
	Total	102	100

Based on the Table 2, it can be seen that most students have a convergent thinking style, which is equal to 66,7% and there were 34 students or 33.3% who had divergent thinking styles. This is in accordance with the results of interviews with chemistry teachers at the

school. There are 68 students who have more points on the convergent thinking style compared to the points on the divergent thinking style. The remaining 34 students had different results from the previous results. So that students cannot divide their focus when dealing with various problems and have not been able to integrate thoughts to solve problems that require higher-order thinking skills. Guilford defined divergent thinking and differentiated it from convergent thinking. While convergent thinking is readily measured by multiple-choice questions, a standardized measurement was needed for divergent thinking (Guilford, 1956). Viewed from the average value, the lowest score, and the highest score, all thinking style research data is depicted in Figure 1.

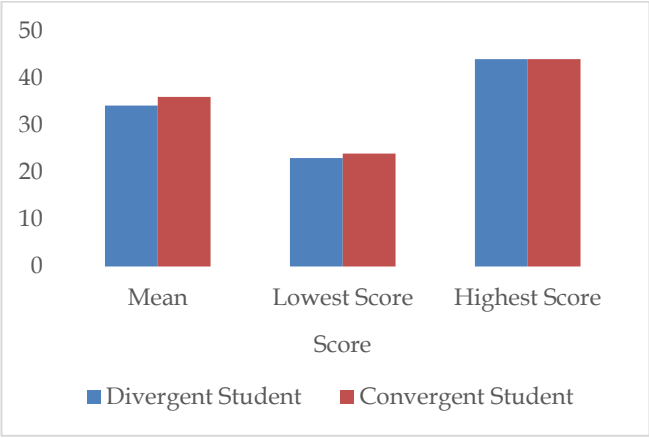

Figure 1. Student's Thinking Styles Data

Figure 1. as far as research on divergent thinking and convergent thinking is concerned, it seems that they have mainly been researched in relation to the issues of creativity, personality traits, cognitive processes, mathematics learning performances, and tasks types and features. First and most noticeably, creativity is the main factor that divergent thinking and convergent thinking have received a close attention in research. Even though there are different views, it is mainly that divergent thinking is being associated with creativity. For instance, based on a meta-analysis, found that a significantly higher relationship does exist between creative achievement and divergent thinking style test scores (Kim, 2008).

Based on the results of research conducted by researchers at SMAN 8 Yogyakarta in chemistry class 4, 5 and 6, it is known that the average score of students with a divergent thinking style is 34.2 with the highest score achieved by one of the students namely 44 and the lowest score achieved. obtained is 23. While the average score of students with a convergent thinking style is 36 with the same highest score of 44 and the lowest score achieved is 24. The difference in scores on the divergent and convergent thinking style questionnaires can be influenced by several factors such as learning styles and learning models used. The bivariate correlation on the variables gender and thinking styles uses crosstab analysis and the Phi Coefficient test, the following are the results of the analysis.

Table 3. Statistical Test of Factors Related to Thinking Styles

Student's Gender	Thinking Styles				Total		Phi	P-Value
	Convergent		Divergent					
	F	%	F	%	F	%		
Female	47	46.1	14	13.7	61	59.8		
Male	21	20.6	20	19.6	41	40.2	0.269	0.007
Total	68	66.7	34	33.3	102	100		

Based on the crosstab analysis in Table 3 the relationship between gender and thinking styles obtained based on gender, female gender students for 47 students have convergent thinking ability or 46.1%, and 14 students have divergent thinking styles or 13.7%. Meanwhile, for male gender students, there were 21 students with convergent thinking styles or 20.6%, and 20 students who had divergent thinking styles or 19.6%. To determine the correlation between the student's gender and thinking styles, an analysis can be carried out using the phi coefficient test, the phi value obtained is 0.269 and the p-value obtained is 0.007. The terms of interpretation are, if the P-value > 0.05, then H_0 is accepted and if the P-value < 0.05, then H_0 is rejected. So that the hypothesis can be set with H_0: there is no correlation between student's gender and thinking styles, and H_a: there is a correlation between student's gender and thinking styles.

Analysis can also be seen from its Significance (Sig) or probability value (P-value). If Sig (P-value) is below or equal to 0.05 then Ha is accepted where as if it is above 0.05 then Ho is accepted. If we look at the results of the SPSS analysis, the Sig (2-sided) or P-value is known to be 0.007. then the conclusion is the alternative hypothesis is accepted (Ha is accepted). It concluded that there is a correlation between student's gender and thinking styles. The influence of thinking styles on attitudes toward AI use is not independent; factors such as educational background, prior exposure to technology, teacher support, and the availability of learning resources play a moderating role. For example, students with divergent tendencies but without access to

devices or mentoring may not be able to reach their potential in AI use (Zawacki-Richter et al., 2019).

Students with convergent tendencies tend to excel in tasks requiring logical precision, data analysis, and structured problem-solving. They are quicker to grasp algorithmic logic, technical procedures, and AI programming steps (Olmo-Muñoz, 2020). Conversely, students with divergent tendencies perform better on tasks requiring creativity, exploration, and the design of innovative AI applications. They are able to generate alternative solutions, develop original ideas, and consider the social and ethical implications of AI use (Torrance, 1966; Marr, 2019). This aligns with Runco and Acar (2012) findings, which suggest that divergent thinking is an important indicator of creative potential.

This study supports the idea that the teaching methods, curriculum and assessments in Indonesia school are still concentrated on the convergent thinking style, which focus on logic thinking, memorizing and obeying instructions. In other words, it is also the hard work of teacher to produce innovative, creative and competent students in the market for the future. Due to the limitations of homogeneous characteristics of the sample and the small sample size, future studies could be conducted widely on school students in all ages and grades to provide a bigger picture of the impacts of gender and thinking style on creative thinking ability. Such studies would provide essential information to educators, especially those from the ministry of education and teacher education division. Finally, it is hope that school teachers would plan their teaching and learning activities in more effective ways as to expand the students' creative thinking ability and nurture their whole potential in achieving the goal of effective education.

Conclusion

Results of this study reflect that there is a great impact of gender to thinking styles. Convergent thinking style in female students more than female students who have a divergent thinking style. The same thing also happens to male students, where there are more male students who have a convergent thinking style compared to male students who have a divergent thinking style, but the male gender is only one student different with a convergent frequency of 21 male students. and divergent as many as 20 male students. While for female students the difference in frequency between convergent and divergent thinking styles is quite far with a frequency of 47 female students with a convergent thinking style and 14 female students with a divergent thinking style. So, it can be concluded that more male students have a divergent thinking style than female students. In spite of this, there was a difference in elaboration component, where the male students were better in elaborating ideas than the female students. It concluded that there is a correlation between student's gender and thinking styles. Both convergent and divergent thinking styles play important roles in the learning and utilization of AI at the high school level. Integrating both into learning strategies, assessments, and curriculum design will help shape student competencies that balance technical accuracy and applied creativity.

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Conceptualization, E.A.P. and A.M.; methodology, E.A.P.; formal analysis, E.A.P.; investigation, E.A.P.; resources, E.A.P. and A.M.; writing—original draft preparation, E.A.P. and A.M.; writing—review and editing, E.A.P. and A.M.

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The authors declare no conflict of interest.

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