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The Effect of Computational Thinking and Gender on Social Problem Solving Learning Outcomes

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Abstract: The Effect of Computational Thinking and Gender on Social Problem Solving Learning Outcomes. Objective: to see the relationship between students' level of computational thinking (CT) on learning outcomes in solving social problems. **Metode:** using descriptive verification method with advanced analysis of K-Means clustering. **Finding:** Male and female learning outcomes are significantly different, where female students on average have higher learning outcomes. CT Men and Women there is no significant difference. There is a significant relationship between CT variables and learning outcomes to solve problems. The results of the K-Means analysis showed that Cluster 3 was a group of women with moderate CT levels and high learning outcomes, while cluster 4 was a group of men with moderate CT levels and moderate learning outcomes. **Conclusion**: female students have higher learning outcomes than male students; there is no significant relationship between CT level and gender; and the results of the K-Mean clustering analysis found 8 clusters.

Keywords: computational thinking, gender, learning outcomes.

Abstrak: Pengaruh Computational Thinking dan Gender Terhadap Hasil Belajar Pemecahan Masalah Sosial. Tujuan: *melihat hubungan antara tingkat computational thinking (CT) mahasiswa terhadap hasil belajar memecahkan masalah sosial.* ***Metode:*** *menggunakan metode deskriptif verifikatif dengan analisis lanjutan clustering K-Means.* ***Temuan:*** *Hasil belajar Pria dan Wanita berbeda secara signifikan, di mana mahasiswa wanita rata-rata memiliki hasil belajar lebih tinggi. CT Pria dan Wanita tidak terdapat perbedaan yang bermakna. Terdapat hubungan signifikan antara variabel CT dengan hasil belajar memecahkan masalah. Hasil analisis K-Means didapatkan Cluster 3 merupakan kelompok wanita dengan tingkat CT sedang dan hasil belajar tinggi, sedangkan cluster 4 merupakan kelompok pria dengan tingkat CT sedang dan hasil belajar sedang.* ***Kesimpulan:*** *mahasiswa wanita memiliki hasil belajar lebih tinggi dari mahasiswa pria; tidak ada hubungan yang signifikan antara tingkat CT dengan jenis kelamin; dan hasil analisis K-Mean clustering ditemukan 8 cluster.*

Kata kunci: *computational thinking, gender, hasil belajar.*

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INTRODUCTION

Learning is a complex internal process involving cognitive, affective, and psychomotor aspects. Anderson & Krathwohl, (2001) redefine the cognitive domain as the meeting point between the cognitive process dimensions and the knowledge dimensions (Heer, 2012). The cognitive process is explained in terms of different theories between behaviorists, connectivists and humanists (Behlol & Dad, 2010). However, all agree that learning at school does not happen by chance, although students will also learn many unplanned things both inside and outside the classroom (Pritchard, 1945).

Cognitive abilities that are oriented towards problem decomposition thinking skills in dealing with problems can be optimized to provide a better learning experience (Selby & Woollard, 2016). This can be done through sports competition activities et al., 2020), learning to think (Santosa, et al., 2020), as well as students' social life. Students' skills in solving these problems are referred to as Computational Thinking (Avcý & Deniz, 2022). Computational thinking is an important ability that students need to have in today's digital era. The importance of these abilities in education was first investigated by Seymour Papert and popularized by Jeannette M. Wing in 2006 (Lodi & Martini, 2021). According to Korkmaz & Bai, (2019), computational thinking is the ability to think innovatively in identifying phenomena, then providing various solutions to address the problems encountered. Thus, computational thinking is a problem-solving skill that is expected to be possessed by critical and innovative young people (Shanmugam & Nadesan, 2019). Computational thinking is also a skill developed to improve children's abilities from an early age in terms of solving problems, designing systems, and understanding human behavior when using basic computational concepts (Espino & González, 2016).

The most efficient way to make students acquire computational thinking skills is to incorporate problem-solving steps into learning with relevant strategies (Avcý & Deniz, 2022). One learning strategy that has the potential to improve systematic thinking skills as an important element of computational thinking is collaborative problem base learning (Jones et al., 2013; Santosa et al., 2020). Apart from that, there are also other strategies that improve algorithmic thinking skills and problem decomposition such as project base learning (Bell, 2010), Collaborative problem-solving (Ghosh et al., 2012; Santosa et al., 2020), and so on. With the right efforts, the growth of computational thinking skills can improve students' ability to solve various learning problems (Rosali & Suryadi, 2021).

Espino & González, (2016) stated that gender determines the level of computational thinking. Research by Tsai et al., (2021) shows that boys have a higher level of computational thinking skills than female students, especially in decomposition thinking when dealing with problems. This opinion is confirmed by the findings of Angeli & Georgiou, (2023) in their research. However, the above conclusions need to be challenged in other studies. In the group model learning conditions, differences in performance were obtained when men were grouped separately and women separately et al., 2017). This means that the characteristics of students based on gender play an important role.

Gender is one of the important factors studied related to computational thinking skills. Chongo et al., (2020) found that the relationship between computational thinking skills and learning achievement was quite significant, while gender differences were found to be insignificant. However, Jiang & Wong, (2022) found otherwise that gender differences did not significantly affect the level of students' computational thinking, but at the student's age level it was even more significant. The differences in the findings

mentioned above need further clarification and testing.

As explained above, Computational thinking is a cognitive approach that emphasizes solving problems using computational principles. Despite its origins in computer science, the concept has great potential in the social sciences. This means that Computational thinking is also very useful for students in solving contemporary social problems they face (Yadav, et al., 2017). This is very much needed for teenagers to be able to choose constructive social attitudes for themselves in the current era of disruption (Syafril, et al., 2022). The right decisions of youth in the current era of disruption will have a broad impact on the social ecosystem of a country.

Computational thinking assists students in analyzing large amounts of data in the social sciences with an algorithmic approach. The use of algorithmic thinking allows students to be able to identify patterns in complex data such as people's behavior, economic preferences, politics, education, interests, hobbies, and cultural trends (Korkmaz & Bai, 2019). In addition, this concept can be applied in a simulation model to better understand the implications of each social policy (Akbar, 2021). The use of computational-based models allows testing of various scenarios before making important decisions. The use of computational thinking is more widespread and complex (Shanmugam & Nadesan, 2019). In fact, it is also important for students to manage the time between their hobby of surfing on social media and completing their college assignments. This ability makes every decision taken systematic and more productive. Especially dangerous problems that threaten health and humanity, such as drug abuse, terrorism, and moral degradation (Hasan & Bao, 2020). All of these social problems always threaten adolescents through various social means. Social media is the most used tool. Adolescents must be able to sort, select and decide on their life choices based on rational, comprehensive and systematic considerations.

The application of computational thinking also encourages students to develop digital literacy skills in seeing many social facts according to their needs (Lundgren et al., 2015, Weinberger et al., 2005). The ability to design and understand algorithms helps students overcome challenges in analyzing data that is abundant and increasingly complex. It also stimulates competency collaboration between social and computer skills, resulting in deeper interdisciplinary insights. Multi-discipline competencies are needed in the current era of society 5.0 (Fukuda, 2020). This competence also allows humans to continue to exist in the midst of increasingly widespread technological disruption. So the integration of computational thinking into social facts has the potential to change the way students understand and deal with contemporary social problems (Xu, et al., 2021). By applying computational approaches to data analysis, simulation models, and digital literacy, social skills will be able to achieve a more comprehensive and in-depth understanding of complex social dynamics (Akbar, 2021).

Preliminary research was conducted through direct observation, it was found that in discussion sessions male students tended to be more active in expressing their opinions regarding various issues presented. Male students are able to describe detailed and systematic problems. However, after conducting a formative evaluation it was found that the learning outcomes of female students on average were higher than those of male students. Based on an initial test of the level of computational thinking on 10 students, it was found that the difference in CT levels between male and female students was not significant. Therefore, based on the description above, this study aims to determine the effect of gender differences on learning outcomes in solving social

problems, differences in students' computational thinking levels based on gender, and the influence of students' computational thinking levels on learning outcomes in solving social problems. In addition, it is necessary to deepen the relationship between each group, the level of student computational thinking and gender towards learning outcomes in solving social problems. The questions above will be answered in this research.

METHODS

Research Design and Participants

Samples are needed because researchers have limitations in conducting research both in terms of time, energy, funds and a very large population size. In this research, the author narrowed down the population, namely the number of students from the S1 Sports Coaching Education, S1 Economics Education and S1 Educational Technology study programs at Sebelas Maret University, Surakarta, totaling 1,219 students. Determining the number of samples uses the Slovin technique according to Sugiyono (2015). The Slovin formula was chosen because in sampling, the numbers must be representative with simple formulas and calculations. The number of samples obtained according to the Slovin formula with N (population) = 1219 students and e (error rate) = 5% is 302 students. So the number of samples that can be used in this research is 256 students. The data collection technique is by sending a Google form link to the student's WhatsApp class group. The measurement scale was adopted from Computational Thinking Scales (Korkmaz, et al., 2017). The data collection process was carried out from May 20, 2023 to June 20, 2023. The sampling technique used was a nonprobability incidental technique.

Instrument

The instrument used is a questionnaire to measure students' level of computational thinking. In the research, the instrument used was a modification of the instrument developed by Korkmaz, et al., (2017). The questionnaire consists of 19 statements with 5 indicator which were translated from the original language, namely English, into Indonesian. The five indicator are: Creativity, Algorithmic Thinking, Cooperativity, Critical Thinking, and Problem Solving (Korkmaz et al., 2017). After carrying out the validity test, it was obtained that r count e" r table, which means the instrument was declared valid. That factors on the scale, number of items and internal consistency coefficient summarized in **Table 1**.

Table 1. Validity analysis results

Indicator	Number of Item	Cronbach's Alpha
Creativity	4	0.78
Algorithmic Thinking	3	0.89
Cooperativity	4	0.88
Critical Thinking	4	0.74
Problem Solving	4	0.81

Data analysis

Quantitative analysis based on the results of computational thinking ability tests. Data analysis used the Wilcoxon test because the data were not normally distributed. Further analysis was carried out using Orange software which includes the K-Means clustering method. The reason for using this software is because it is open source software. Further analysis of this study uses K-Means for clustering. While the analysis of the relationship between variables used Spearman's rho, because the data is not normally

distributed. Data collection was carried out by sending a Google form link to the WhatsApp group of students taking the Pancasila Education course.

■ RESULTS AND DISCUSSION

The results of data analysis to answer questions about the influence of gender on learning outcomes to solve problems are as follows: shows a U value of 6609.5 and a W value of 12387.5. When converted to a Z value, the magnitude is -2.292. The Sig or P Value is 0.022 <0.05. If the p value <critical limit of 0.05 then there is a significant difference between the two groups or which means H1 is accepted. This shows that there are significant differences in the learning outcomes of male and female students. Furthermore, it can be seen that the average learning outcomes of female students are higher than male students.

The results of data analysis to test the relationship between the level of computational thinking and gender can be seen : U value of 7679.5 and a W value of 18705.5. When converted to a Z value, the magnitude is -0.411. The Sig or P Value is 0.681 > 0.05. If the p value is > the critical limit of 0.05 then there is no significant difference between the two groups or which means H1 is rejected. This shows that there is no significant difference in male and female computational thinking.

The results of data analysis that measures the correlation between computational thinking and learning outcomes: Based on the calculation of the correlation between computational thinking variables and learning outcomes, a correlation coefficient of 0.862 is obtained with a significance of 0.000. From these results obtained a significance of 0.000 <0.05 (smaller) then the research hypothesis was rejected. Then it can be concluded that there is a significant relationship between computational thinking variables and learning outcomes. Positive coefficient numbers show a positive relationship, that is, if computational thinking increases, learning outcomes will increase. On the other hand, if computational thinking goes down, then learning outcomes will go down too.

Further analysis will use k-means clustering analysis to see the groups in the data. The analysis steps can be seen in the following figure:

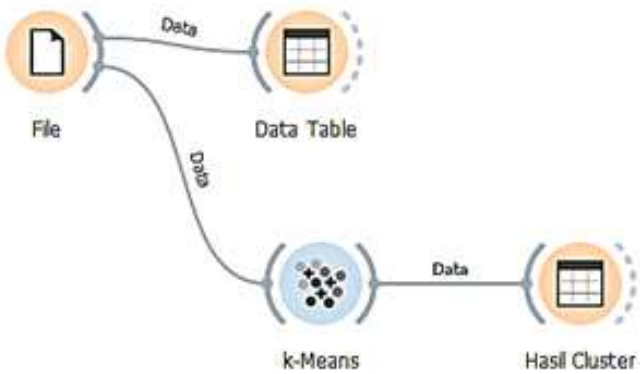

Figure 1. K-means clustering analysis steps

From the Silhoutte Score it is recommended that there be eight clusters. Each cluster has different characteristics. Cluster 1 is a group of female students with moderate levels of computational thinking and moderate learning outcomes. Meanwhile, Cluster 2 is a group of male students with a high level of computational thinking and high learning outcomes. Furthermore, Cluster 3 is a group of female students with a moderate level of computational thinking and high learning

outcomes. Next is Cluster 4, which is a group of male students with a moderate level of computational thinking and moderate learning outcomes. Cluster 5, is a group of female students with low levels of computational thinking and low learning outcomes. Cluster 6, is a group of male students with a high level of computational thinking and high learning outcomes. Cluster 7, is a group of female students with a high level of computational thinking and high learning outcomes. The last cluster is cluster 8, which is a group of male students with low levels of computational thinking and low learning outcomes.

Discussion of the results of this study became very interesting. Computational thinking is a cognitive, affective, and conative process of students applying concepts and systematic methodologies to create solutions to existing problems (Sovey, Osman, & Matore, 2022). Many studies link the level of computational thinking with learning outcomes (Shanmugam & Nadesan, 2019; Chongo et al., 2020; Angeli & Georgiou, 2023). Besides that, Computational thinking is also widely seen from a gender perspective (Espino & González, 2016). The research has tested the relationship between the level of Computational thinking, gender and learning outcomes in solving social problems.

According to research by Sovey et al., (2022) it shows that gender factors and computational thinking have an effect on the ability to provide solutions to problems. This was confirmed in this study that there is a correlation between learning outcomes and gender. It was found that female students had better learning outcomes in solving social problems than male students. This shows that women are able to use a systematic and logical methodology in solving social problems faced by them. This ability develops with age and maturity of thinking (Jiang & Wong, 2022).

In this study it was also found that there was no significant difference in the level of computational thinking between male and female students. This means that the potential of each student in solving problems based on computational thinking is relatively equal. Each gender group has a high, medium or low level of Computational thinking. The level of Computational thinking in each group of students is not determined by gender or age, but rather by the maturity level of scientific thinking for each individual (Angeli & Valanides, 2020; Espino & González, 2016; Jiang & Wong, 2022). However, the findings of this study differ from the opinion of Angeli & Georgiou, (2023) which states that the level of computational thinking between men and women is significantly different. Where the level of computational thinking for men is higher in various ways than for women's computational thinking. This happened perhaps because the research was conducted on children aged between 5 and 6 years, so that the intervention factor before learning was more dominant (Sovey et al., 2022). Meanwhile, this research was conducted on students aged between 19 to 21 years who were pursuing higher education.

The results also show that computational thinking and learning outcomes have a very strong correlation. It means that the level of computational thinking determines the learning outcomes of solving social problems. These findings confirm the findings of research by previous researchers linking computational thinking with algorithmic thinking skills and problem decomposition (Yadav et al., 2017; Moon et al., 2020; Rosali & Suryadi, 2021).

However, this study found that from the results of the clustering analysis there is a fact that the female gender group with a moderate level of computational thinking has high learning outcomes in solving social problems. This is different from cluster 4 of the male gender group,

where the results of computational thinking still have moderate learning outcomes. So it is found that at the level of computational thinking, the learning outcomes of men and women are different. Based on these results, it is suspected that there are other factors that support learning outcomes besides the level of computational thinking of students in the female gender group. Other factors that may influence are the level of self-regulated learning (Santosa et al., 2020), learning styles (Yuzela, et al., 2023), the level of critical thinking et al., 2017), the level of internet self-affication (Santosa & Sarwanta, 2021), or other related internal and external factors. It is necessary to do more in-depth research related to other factors determining the level of social problem solving learning outcomes.

■ CONCLUSIONS

The conclusions of this study answer the research questions that have been asked. The results of the study show that there is an influence of gender on learning outcomes in solving social problems. In this study it was found that female students had higher learning outcomes than male students. The second conclusion is that there is no significant relationship between the level of students' computational thinking and gender. This means that there is no significant difference in the level of computational thinking of male and female students. In other words, gender does not conclusively influence the level of computational thinking.

The third conclusion is that there is a significant influence on the level of student computational thinking on the learning outcomes of solving social problems. The results of the K-Mean clustering analysis found 8 clusters. However, it was found in cluster 3 that a group of female students with moderate levels of computational thinking had high learning outcomes. Whereas in cluster 4, which is a group of male students with a moderate level of computational thinking, they only have moderate learning outcomes. This raises a new research question whether there are other factors that female students have at a moderate level of computational thinking so that they get high learning outcomes in solving problems.

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