Jurnal Pendidikan Sains Indonesia 11(4), p.767-783, (2023)
(Indonesian Journal of Science Education) e-ISSN: 2615-840X p-ISSN: 2338-4379
URL: http://jurnal.usk.ac.id/JPSI/index DOI: doi.org/**10.24815/jpsi.v11i4.31760**

Biology-Critical Thinking Skills of High School Students in Terms of Gender and School Location

Suci Hatru Ramadhani*, Puguh Karyanto, Bowo Sugiharto

Department of Biology Education, Faculty of Teacher Trainng and Education, Sebelas Maret University, Surakarta, Indonesia

*Email: Sucihatruramadhani@student.uns.ac.id

Article History:
Received date: April 15, 2023
Received in revised from: August 21, 2023
Accepted date: September 29, 2023
Available online: October 8, 2023

Citation:
Ramadhani, S.H., Karyanto, P., & Sugiharto, B. 2023. Biology-critical thinking skills of high school students in terms of gender and school location. *Jurnal Pendidikan Sains Indonesia (Indonesian Journal of Science Education)*, 11(4):767-783

Abstract. Students' critical thinking skills (CTS) in Indonesia are still relatively low. This study describes students' and the relationship between CTS and their gender and school location. The research was conducted using a cross-sectional survey method. The sampling technique was convenience sampling involving 91 men and 134 women from 7 public high schools in Bener Meriah district which are located in rural areas and 4 are located in urban areas. Students' CTS were measured using essay tests collected via google form and the results were analyzed descriptively. Furthermore, a correlation test was carried out between gender and students' school location on CTS with the Pearson correlation in the SPSS 25 program. The results showed that the value of students' CTS who attended urban areas had an average score of 48.6, while those who attended rural areas of 36.6. The average score of the boys was 39.4, while the average score of the girls was 50.3. The relationship between gender and CTS shows a value of 0.217, while the relationship between school location and CTS shows a value of -0.117. It was concluded that students who attend schools in urban areas have superior CTS compared to those in rural areas and female students are superior to male students. The relationship between school location and gender on students' CTS is low.
Keywords: Critical thinking skill, biology learning, gender, school location

Introduction

In the 21st century, humans are faced with unexpected problems, even uncontrollable ones (Kocak et al., 2021). The education system is required to emphasize individuals be lifelong learners, able to manage complex ways of thinking and working, creative problem solvers, use the knowledge and skills they gain to new situations, analyze new information and ideas, communicate, collaborate, make decisions, continue to learn and develop, to position themselves in a world with the flow of globalization, technology, information, and communication are developing very rapidly (Sahin, 2009; Schleicher, 2012; Sturner et al., 2017).

These very comprehensive 21st-century skills are a demand for students, namely, students must have high-order thinking skills one of which is critical thinking skills (Brookhart, 2010; Sturner et al., 2017; Sun et al., 2022). The education system in Indonesia through the implementation of curriculum has emphasized the learning process that can create human resources who have 21st-century competencies and skills, namely critical thinking skills (CTS) (Kemdikbud, 2013; Kemdikbudristek, 2022).

Critical thinking is an individual's skill in interpreting, analyzing, inferring, evaluating, explanations, and self-regulation (Facione, 2011). Critical thinking gives

learners the ability to make evidence-based judgments (Pislaengam, 2018; Reynders et al., 2020), context, theory, methods, and criteria to monitor, correct, increase self-awareness, identify alternatives, analyze assumptions, weigh consequences, and arrive at the right decision (Seibert, 2022). Critical thinking can indirectly improve because it is a basic step for problem-solving and has a mediating effect on creativity, algorithmic thinking, cooperation, and digital literacy (Kocak et al., 2021).

Critical thinking can increase student learning motivation. Students who have CTS can involve themselves in making decisions, know the benefits of learning, have different ways of thinking, and have an interest in learning and a desire to succeed (Ahmad & Ismail, 2023). So that students can become serious learners, realizing that someone will become smarter through continuous and focused efforts and they can achieve more than what they usually expect and develop over time by solving difficult problems and working on challenges to achieve what they want. they want (Chadwick, 2014). Critical thinking also has a positive relationship with a student's learning outcomes, especially in biology learning (Andini et al., 2022; Cindiati et al., 2021; Fatmawati et al., 2019; Fitriani et al., 2020; Ulfah & Nurmaliah, 2020).

Biology learning requires students to think of constructivist ideas and practice CTS that provide basic questions such as who, what, when, where, and questions about causation, namely how, and why (Allcoot et al., 2014; Jenkins, 2015). CTS in biology learning, helping students actively use their knowledge, becoming lifelong learners, forming views on the scientific world, so that they can establish relationships between humans and the world and can overcome various problems in the field of Biology needed by innovators, biologists, scientists, and future leaders through discovery and decision-making activities which is appropriate as a solution (Mardonov, 2019; Munawarah et al., 2018; Nurse, 2016). Students are prepared to adapt to the potential applications of advances in the field of biology such as supporting sustainable development goals by utilizing the development of medical biology, molecular biology, genetic engineering, human genome projects, evolution, e-genetics, and technology so that future scientists understand their role and impact on society (Khalil et al., 2014; Wibowo & Sadikin, 2019).

However, currently in Biology learning, students are still at the level of CTS that still have to be developed (Munawarah et al., 2018). This can be proven by Indonesia's PISA score in the field of science in 2018 still shows an unsatisfactory number, namely a value of 396. This value is lower than that of OECD and ASEAN countries (Kemdikbud, 2019). In addition, based on the results of the National Examination in Biology of senior high school students in 2018-2019, Acehnese students scored 42.69 which indicates students' CTSin moderate-level conditions (Kemdikbud, 2019). The CTS of senior high school students in Aceh are still developing status (Kemendikbudristek, 2022).

This can be caused by several factors that affect CTS, including student perception, school location (Kurniawan et al., 2023; Sari et al., 2019), teacher teaching quality, teacher, teaching behavior, student confidence, student pedagogical conditions, child parenting patterns (Akmam et al., 2019; Thongnuypram, 2013; Ugwuozor et al., 2020), emotional intelligence (Sahanowas & Halder, 2020), student mood, cognitive abilities and propensity to pay attention to truth (Lun et al., 2023), gender, parents' education level, parents' occupation, the area of residence (Arslan et al., 2014), and students' metacognitive (Kudus, 2022).

In Indonesia, critical thinking research on upper middle school students in biology learning has been carried out to find out how to profile students' CTS through various approaches (Fitriani et al., 2022; Mahanal et al., 2019; Nugroho et al., 2022; Saputri et al., 2018; Tambunan et al., 2018). However, there has been no research to measure

students' CTS in learning biology in Aceh, especially in Bener Meriah Regency. From various factors, researchers are interested in looking at the picture of students' CTS and seeing whether students' CTS are related to the gender and location of students' schools (rural and urban). It is based on a learning environment that has a role in learning and determines performance in student studies. Because the location of rural and urban schools is related to facilities and quality of learning, previous research results show an uncertain relationship (Darmaji et al., 2020; Kurniawan et al., 2023; Sari et al., 2019; Tamam et al., 2021; Tanti et al., 2020). Research on critical thinking based on gender has also been conducted (Darmaji et al., 2021; Harun, 2021; Iyus & Bustami, 2022; Rahman, 2018; Supriyati & Djukri, 2021; Tamam et al., 2021). Gender has also been associated with students' academic task performance in various studies but without definite and inconsistent conclusions (Ibrahem et al., 2022). Some research

results show that the female sex has higher CTS than the male sex (Arslan et al., 2014; Kurniawan et al., 2023; Mawaddah et al., 2018). In other studies, it shows that the male gender has advantages in critical thinking (Ibrahem et al., 2022), and other studies do not show a relationship between gender and critical thinking (Liu et al., 2019; Sahanowas & Halder, 2020).

Based on the explanation above, critical thinking is very important and can determine students' success in learning and their future. Research regarding the level of students' critical thinking abilities must continue to be carried out. This research aims to describe students' critical thinking abilities in terms of gender and school location as well as the relationship between students' critical thinking abilities and students' gender and school location at Bener Meriah District Public High School, so that it can be used as evaluation material for teachers, practitioners and education policy makers. to implement strategies to increase students' critical thinking.

Methods

This study is an analytical survey research using a cross-sectional design, which aims to find information on how students' CTS are based on gender and school location and study the correlation between gender and the students' with CTS. Data collection was collected at a single point in time and was not repeated (Cohen & Morrison, 2011; Patricia, 2017) by online via google form from December 1-15, 2022.

Research samples were taken using non-probability techniques, namely techniques that do not provide equal opportunities for each member of the population to be selected as a sample (Sugiyono, 2017). The sampling technique used is *convenience sampling*, where researchers choose participants who are willing to be studied (Creswell, 2015). The participants who were willing to be studied were as many as 225 grade XI science students from 11 public high schools in the Bener Meriah district, Aceh. Students are then categorized by gender, i.e., female and male, and by school location, i.e., local locations in rural and urban area (see Table 1). The determination of the demographic category of school locations (rural and urban), is based on the Regulation of the Head of the Central Statistics Agency Number 120 of 2020 concerning the classification of Urban and Rural in Indonesia (Heriyana et al., 2020). Based on classification regulations, this study was followed by 7 schools located in rural areas and 4 schools located in urban areas**.**

Table 1. Student demographic information by school location and gender

Demographics		n=225
		N
School location	Rural	174
	Urban	51
Gender	Man	91
	Woman	134

The measurement tool for students' CTS uses a written test in the form of an essay test of 6 questions with Biology question material adjusted to the basic competencies of the 2013 curriculum, namely the human excretory system, human respiratory system, human coordination system, environmental changes, ecosystems. The essay test instrument was then developed by referring to indicators of CTS according to Facione (2011), namely interpretation, analysis, inference, evaluation, explanation, and self-regulation. The research instruments that have been developed are then validated by 2 experts to obtain suggestions and criticisms to improve the quality of question items. Furthermore, the question items were tested for validity and reliability through the SPSS 25 program. Item validity tests are tested using Pearson correlations. The results show that each question item has a r count greater than the r table (0.131), so it can be concluded that all CTS question items are valid (Table 2). Reliability tests are checked using Cronbach's alpha (α). The result is 6 items of CTS questions have a Cronbach's alpha (α) value of 0.835. If the value $\alpha > 0.8$, it is concluded that CTS have high reliability (Ekolu & Quainoo, 2019).

Table 2. The results of the validity test of the question items' CTS on each indicator of the question items

Question items	r table	r count	Interpretation
1	0.131	0.762	Valid
2	0.131	0.711	Valid
3	0.131	0.745	Valid
4	0.131	0.810	Valid
5	0.131	0.689	Valid
6	0.131	0.732	Valid

The results of the student's CTS essay test were then analyzed descriptively by looking at the average scores of students' CTS based on gender and school location obtained from the data. The average score results are classified based on five levels of CTS criteria (Sari et al., 2019) shown in Table 3.

Table 3. The Student critical thinking skills category

CTS Score	Category
0 - 20	Very low
21 – 40	Low
41 – 60	Medium
61 – 80	High
81 – 100	Very High

Furthermore, to find out whether there is a relationship between gender and student school location on their critical thinking abilities, the data was analyzed with Pearson correlation in the SPSS 25 program. The results of data analysis are then classified according to the correlation category (Schober & Schwarte, 2018) shown in Table 4.

Table 4. Category correlation coefficient

Coeficient Correlation Value	Interpretation
0.90-1.00	Very strong correlation
0.70-0.89	Strong correlation
0.40-0.69	Medium correlation
0.11-0.39	Low correlation
0.00-0.10	Negligible correlation

The condition that must be carried out is that the data must be normally distributed and homogeneous, so that the data must be tested for prerequisites first, namely for the normality test and homogeneity test.

Results and Discussion

The results of CTS in terms of school location and gender, in general, can be seen in Table 4. The results showed that CTS in terms of school location and gender had different average scores and standard deviations. Students who attended school in urban areas (mean= 48.6, standard deviation= 21.7) had higher CTS compared to students who attended rural schools (mean= 36.6, Std. Dev= 32.0). Based on the average score, it represents that the level of CTS of students who attend schools in cities is in the medium category and students who attend schools in villages have a low level of CTS. This result is from the research of Darmaji et al. (2020) and Domike & Odey (2011) that the CTS of students who attend schools in urban are superior to students who attend schools in rural. Students in rural areas tend to obtain lower knowledge scores and perform compared to students in urban areas (Anlimachie & Avoada, 2020; OECD, 2013; Tangoa-Villacorta et al., 2017; Wagh, 2022).

The results of CTS in terms of gender, average scores, and standard deviations of CTS of women and men also showed differences. Male students' CTS (mean= 39.4, std. dev= 26.0) were lower than those of female students (mean= 50.3, std. dev= 22.9). The data represents that the level of CTS of male students is in the low category and female students have a medium level of CTS. This result is supported by other studies that say that women have higher abilities than men (Iskifoglu et al., 2022; Kurniawan et al., 2023; Perdana et al., 2019; Shubina & Kulakli, 2019; Tamam et al., 2021).

Table 4. The results of students' CTS categories based on school location and gender

Demographics		Mean	Std. Deviation	Interpretation
School location	Urban	48.6	21.7	Medium
	Rural	36.6	32.0	Low
Gender	Man	39.4	26.0	Low
	Woman	50.3	22.9	Medium

This study measured six indicators of CTS according to Facione, namely skills in interpretation, analysis, inference, explanation, evaluation, and self-regulation in terms of school location and gender. From six indicators, it can be seen that students who attend urban schools have higher average scores than students who attend rural schools. Female students are also superior to male students on each indicator. In full, the results of the average score of CTS of each indicator in terms of school location and gender can be seen in Table 5.

Based on these results, it was concluded that female students seemed to be superior in every indicator of CTS to male students. This is to several previous studies that stated that female students are superior in terms of analytical skills (Arslan et al., 2014; Gunawan et al., 2020; Perdana et al., 2019; Prasadh & Titus, 2021), interpretation, evaluation, and self-regulation, explanation (Darmaji et al., 2020; Sari et al., 2018), and conclusion (Din & Ghani, 2019).

Table 5. The results of students' CTS on each indicator based on school location and gender

Indicators of CTS	School location	Mean	Std. dev.	Gender	Mean	Std. dev.
Interpretation	Urban	3.63	2.967	Man	2.81	2.883
	Rural	3.10	3.425	Woman	3.98	3.125
Analysis	Urban	3.78	2.825	Man	3.10	2.844
	Rural	3.16	3.518	Woman	4.00	3.056
Inference	Urban	6.95	5.092	Man	5.11	4.829
	Rural	4.12	4.659	Woman	7.13	5.180
Explanation	Urban	11.43	5.951	Man	9.57	6.880
	Rural	9.78	8.427	Woman	12.06	6.245
Evaluation	Urban	9.94	5.627	Man	8.60	6.598
	Rural	7.45	6.932	Woman	9.90	5.563
Self-regulation	Urban	12.16	7.615	Man	9.97	8.178
	Rural	10.47	10.039	Woman	13.01	8.071

The superiority of CTS of female students compared to men is also evident from the researchers' findings on their test responses. Female students show seriousness in giving ideas, indigently, complexly, and logically compared to male students in answering each question item. Meanwhile, the results of the study were based on a review of school locations that each indicator of CTS looked better in students who attended urban schools compared to rural areas (Darmaji et al., 2020; Din & Ghani, 2019; Turan et al., 2022). Students who go to rural schools tend to answer each question item unclearly, incompletely, and illogically and do not even give their answers to the question items given, which indicates that their CTS are low. Furthermore, prerequisite tests, namely the normality test and homogeneity test are used as conditions for the Pearson correlation test. In this study, the normality test used was the Kolmogorov-Smirnov Test to determine whether the data were normally distributed or not. If the significant value is greater than 0.05, then the data shows that the data group is normally distributed. Meanwhile, if the significance value is less than 0.05, then the data is not normally distributed. The results of the normality test on CTS group data in terms of gender and school location can be seen in Table 6.

Table 6. Normality test results based on gender group data and school location

Demographics of CTS		Test Kolmogorov-Smirnov[a]		
		Statistics	Df	Sig.
School location	Urban	.045	174	.200
	Rural	.179	51	.000
Gender	Man	.086	91	.094
	Woman	.057	134	.200

In the data, the location of the urban school has a significant value of 0.200 and the location of the school in the rural areas is 0.00 so it can be concluded that the sample of students from the urban comes from a normally distributed population while the sample of students with a school location from the rural does not come from a normally distributed population. The sample data for gender has a significance value of 0.094 in male and 0.200 in the female, which indicates that the sample data are both normally distributed.

The homogeneity test is then performed as a prerequisite test to see if the sample comes from a population that has the same or homogeneous variant. If the sample data has a significance value greater than 0.05, then the data comes from a homogeneous population. However, if the significance value is less than 0.05, then the data are not homogeneous. The results of the homogeneity test can be seen in Table 7.

Table 7. The results of homogeneity test on group data based on gender and school location

Demographics of CTS	Levene Statistic	df1	df2	Sig.
School Location	28.922	1	223	.000
Gender	3.083	1	223	.080

The results of the homogeneity test showed that the significant value in the school location group data was 0.000. This indicates that the school location group data is not homogeneous because the significant value is smaller than 0.05. While the significant value in the gender data is 0.080 which indicates that the value is greater than 0.05, so the sample of students by gender comes from a homogeneous population. Based on the results of these prerequisite tests, a person correlation test was then carried out to determine whether or not there was a relationship between gender and CTS (Table 8), and a Spearman's rho correlation test to determine the relationship between school location and CTS (Table 9). The Spearman's rho correlation is used because of abnormally distributed and inhomogeneous school location data (Mukaka, 2012).

Table 8. The results of the Pearson correlation test between gender and students' CTS

		Gender	CTS
Gender	Pearson correlation	1	0.217
	Sig. (2-tailed)		0.001
	N	225	225
CTS	Pearson correlation	0.217	1
	Sig. (2-tailed)	0.001	
	N	225	225

Based on Table 8, the value of sig. (2-tailed) obtained is lower than 0.05 which is 0.001. These results showed that the data were significant or there was a relationship between gender and students CTS. The results of the Pearson correlation test show a correlation coefficient value of 0.217. This indicates that the degree of relationship between gender and CTS has a low correlation (according to Table 10). Although the results of this gender difference show a low correlation number (Else-Quest & Hyde, 2021), further analysis is needed on this relationship, because the average data shows female students have higher scores than men.

It is assumed that female students have high curiosity and confidence compared to men and have different learning interests in each student (Rahman, 2018). High curiosity and self-confidence greatly affect the improvement of CTS (Sun et al., 2022). Verbal and analytical skills in women are superior to men so abilities such as vocabulary, analogy, reading comprehension, and essay writing are also mastered by women. Women are also more responsive to evaluative feedback than men (Tamam et al., 2021). Therefore, based on observing students' responses to CTS tests, female students tend to be able to answer, describe ideas, conclude, and evaluate problems precisely, logically, and complexly.

Table 9. The results of the Spearman' rho correlation test between school location and students' CTS

		School Location	CTS
School Location	correlation coefficient	1	-0.117
	Sig. (2-tailed)		0.080
	N	225	225
CTS	correlation coefficient	-0.117	1
	Sig. (2-tailed)	0.080	
	N	225	225

Sig value. (2-tailed) the school location data shows a value of 0.080, which is higher than 0.05. The results showed that the data was not significant, namely the absence of a relationship between school location and students' critical thinking skills. However, if you look at the value of the correlation coefficient, it shows a value of -0.117 which indicates that the correlation between school location and students' CTS is low (Table 9). It is assumed that socio-economic factors can be the cause of differences in students' ability to think critically. In urban environments, students enjoy more socio-economic benefits, such as better educational facilities, and better living environments (OECD, 2013; Sun et al., 2022). Students who attend school in rural areas tend to be at lower poverty levels. This is a significant obstacle to rural education (Anlimachie & Avoada, 2020; Tangoa-Villacorta et al., 2017). These obstacles include the family's ability to support their children's education. Urban families with better socio-economic are better able to support children's schooling than families in rural areas (Anlimachie & Avoada, 2020). According to some studies, almost all students in urban areas discuss education plans after high school with their parents, while families in rural areas do not (Knoblauch & Chase, 2015; McCracken & Barcinas, 1991; Shreve, 2021). It is assumed that this can be the cause of weak student motivation in rural areas (Wagh, 2022). Student motivation is very positively related to improving students' CTS (Liyanto et al., 2021; Muwaffiq et al., 2020).

In addition, the effectiveness of biology teachers in schools also affects students' critical thinking skills. Teachers in urban areas are more likely to have a higher number of

qualified teachers (OECD, 2013; Wagh, 2022). Teachers in urban schools tend to be more in their readiness, confidence, and self-efficacy. Another factor, it is assumed that educational resources and facilities are inadequate in rural schools (Knoblauch & Chase, 2015). Urban schools have adequate access to the use of technology in student learning, such as access to wider reference materials (Else-Quest & Hyde, 2021; Khanal, 2016) to support their CTS (Wagh, 2022).

Conclusion

Students' CTS in learning Biology are still not well-empowered and need to be improved. The results showed that there is a CTS gap between students who attend school in urban areas and villages and between male and female students. The results of the study concluded that the level of CTS of students who attend schools in cities and are female is in the medium category and students who attend schools in villages and are male have a low level of CTS. The results of the correlation test between school location and gender on students' CTS were low correlated. This study was limited by a cross-sectional design, so this study was unable to conclude causation. So, a deeper analysis is needed on the causes of the gap in CTS of male and female students in urban and rural schools in Bener Meriah Regency so that innovative solutions can be found to empower students' CTS in Bener Meriah Regency in biology learning. This research continues to be needed to see the condition of students' CTS so that teachers and education practioners can continue to find solutions to overcome these problems.

Acknowledgement

The author thanks the Aceh Resource Development Agency (BPSDM) for providing researchers with the opportunity to conduct master studies through the master's study assignment scholarship program for Aceh civil servant teachers and finance this research process. The author also thanks the Head of the Bener Meriah District Education Office Branch, the principal of a Public High School in Bener Meriah Regency, and the respondents who have supported and assisted in the implementation of this research.

References

Ahmad, A. & Ismail, J. 2023. Effects of biology 21st century teaching strategies on student's motivation. *Indonesian Journal of Educational Science and Technology (Nurture)*, 2(1):15–28. https://doi.org/10.55927/nurture.v2i1.2955.

Akmam, A., Anshari, R., Jalinus, N., & Amran, A. 2019. Factors influencing the critical and creative thinking skills of college students in computational physics courses. *Journal of Physics: Conference Series*, 1317(1):1–5. https://doi.org/10.1088/1742-6596/1317/1/012172.

Allcoot, H., Braghieri, L., Eichmeyer, S., & Gentzkow, M. 2014. *Teaching Secondary Biology Third Edition*. United Kingdom: Hodder Education.

Andini, W.N.A., Suprapto, P.K., & Meylani, V. 2022. On the relationship between critical thinking skills, biology learning outcomes, and their visual learning style. *Jurnal Mangifera Education*, 7(1):22–32. https://doi.org/10.31943/mangiferaedu.v7i1.137.

Anlimachie, M.A. & Avoada, C. 2020. Socio-economic impact of closing the rural-urban gap in pre-tertiary education in Ghana: context and strategies. *International Journal of Educational Development*, 77(102236):1–29. https://doi.org/10.1016/j.ijedudev. 2020.102236.

Arslan, R., Gulveren, H., & Aydin, E. 2014. A research on critical thinking tendencies and factors that affect critical thinking of higher education students. *International Journal of Business and Management*, *9*(5):43–59. https://doi.org/10.5539/ijbm.v9n5p43.

Brookhart, S.M. 2010. *How to Assess Higher-Order Thinking Skills in Your Classroom*. USA: ASCD publications.

Kemdikbud. 2013. *Peraturan menteri pendidikan dan kebudayaan nomor 69 tahun 2013 tentang kerangka dasar dan struktur kurikulum Sekolah Menengah Atas/Madrasah Aliyah*. Jakarta: Biro Hukum dan Organisasi Kementerian Pendidikan dan Kebudayaan

Chadwick, C. 2014. *Teaching Kids to Think Critically Effective Problem Solving and Better Decisions*. USA: The Rowman & Littlefield Publishing.

Cindiati, M., CLaudianingrum, H., Ramadhanty, J.A., Suprapto, P.K., & Diella, D. 2021. The correlation between critical thinking skills and the learning outcomes on musculoskeletal system. *Bioedukasi: Jurnal Pendidikan Biologi*, 14(2):122–133. https://doi.org/10.20961/bioedukasi-uns.v14i2.52079.

Creswell, J. 2015. *Riset Pendidikan: Perencanaan, Pelaksanaan, dan Evaluasi Riset Kuantitatif dan Kualitatif* (5th ed.). Yogyakarta: Pustaka Pelajar.

Darmaji, Astalini, Kurniawan, D.A., & Ginting, A.A. 2021. Relationship of science process skills on critical thinking ability review by gender in Madrasah Aliyah. *Jurnal Pendidikan Sains Indonesia (Indonesian Journal of Science Education)*, 9(4):711–735. https://doi.org/10.24815/jpsi.v9i4.21391.

Darmaji, D., Astalini, A., Kurniawan, D.A., & Putri, W.A. 2021. Rural student analysis : correlation science process skills and critical thinking at a state senior high school in Jambi province. *Ta'dib*, 24(2):230–250. https://doi.org/10.31958/jt.v24i2.3645.

Darmaji, Kurniawan, D.A., Astalini, Perdana, R., Kuswanto, & Ikhlas, M. 2020. Do a science process skills affect on critical thinking in science? Differences in urban and rural. *International Journal of Evaluation and Research in Education*, 9(4):874–880. https://doi.org/10.11591/ijere.v9i4.20687.

Din, M. & Ghani, M. 2019. Evaluating university students' inference making ability: a study at bachelor level in Pakistan. *International Journal of English Linguistics*, 9(5):351–361. https://doi.org/10.5539/ijel.v9n5p351.

Domike, G.C. & Odey, E.O. 2011. Teachers pattern of instruction and location on pupils critical thinking in science achievement in Imo state. *Global Journal of Educational Research*, 10(1):1–6. https://www.ajol.info/index.php/gjedr/article/view/79039/69349.

Ekolu, S.O. & Quainoo, H. 2019. Reliability of assessments in engineering education using Cronbach's alpha, KR and split-half methods. *Global Journal of Engineering Education*, http://www.wiete.com.au/journals/GJEE/Publish/vol21no1/03-Ekolu-S.pdf.

Elsequest, N. & Hyde, J.S. 2021. *The Psychology of Women and Gender : Half the Human Experience*. India: Sage Publications.

Facione, P.A. 2011. *Critical Thinking : What It Is and Why It Counts*. Millbrae: Measured Reasons and The California Academic Press.

Fatmawati, A., Zubaidah, S., Mahanal, S., & Sutopo. 2019. Critical thinking, creative thinking, and learning achievement: how they are related. *Journal of Physics: Conference Series*, 1417(1):1-10. https://doi.org/10.1088/1742-6596/1417/1/012070.

Fauzi, A. 2019. Profile of junior high school students' critical thinking skills in answering questions related to biological concepts. *Scientiae Educatia*, 8(1):51-63. https://doi.org/10.24235/sc.educatia.v8i1.4081.

Fitriani, A., Zubaidah, S., & Hidayati, N. 2022. The quality of student critical thinking: A survey of high schools in Bengkulu, Indonesia. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, 8(2):142–149. https://doi.org/10.22219/jpbi.v8i2.18129.

Fitriani, A., Zubaidah, S., Susilo, H., & Muhdhar, M.H.I.Al. 2020. The correlation between critical thinking skills and academic achievement in biology through problem based learning-predict observe explain (PBLPOE). *International Journal of Learning*, *6*(3):170–176. https://doi.org/10.18178/IJLT.6.3.170-176.

Fuad, N.M., Zubaidah, S., Mahanal, S., & Suarsini, E. 2017. Improving junior high schools' critical thinking skills based on test three different models of learning. *International Journal of Instruction*, 10(1):101–116. https://doi.org/10.12973/iji.2017.1017a.

Gunawan, G., Harjono, A., Herayanti, L., Husein, S., & Fathoroni, F. 2020. Investigating student's critical thinking disposition based on gender in physics teaching with interactive multimedia. *JPPS (Jurnal Penelitian Pendidikan Sains)*, *9*(1):1766-1771. https://doi.org/10.26740/jpps.v9n1.p1766-1771.

Harun, S.C. 2021. Gender differences regarding the ability to think critically in high school biology subjects during the covid-19 pandemic. *Jurnal Biologi-Inovasi Pendidikan*, 3(3):179–182. https://doi.org/10.20527/bino.v3i3.10964.

Helgeson, V.S. 2012. *The Psychology of Gender*. USA: Pearson Education.

Heriyana, A., Pazanudin, F., Rosiadi, A., Prehandoko, D.S., Yanti, F., Husjakarsih, I., Dwicahyo, M., Nasrul, Pertiwi, R.P., Nefriana, Narulita, R., Surbakti, S.R., & Maylani, Z. 2020. *Peraturan Kepala Badan Pusat Statistik Nomor 120 Tahun 2020 Tentang Klasifikasi Desa Perkotaan dan Perdesaan di Indonesia 2020, Buku 1 Sumatera*. Jakarta: Badan Pusat Statistik.

Ibrahem, U.M., Alsaif, B.S., Alblaihed, M., Ahmed, S.S.I., Alshrif, H.A., Abdulkader, R.A., & Diab, H.M. 2022. Interaction between cognitive styles and genders when using virtual laboratories and its influence on students of health college's laboratory skills and cognitive load during the Corona pandemic. *Heliyon*, 8(4):1-17. https://doi.org/10.1016/j.heliyon.2022.e09213.

Iskifoglu, T.C., Cerkez, Y., & Iskifoglu, G. 2022. Thinking culture and critical thinking dispositions of high school students in Turkish Republic of Northern Cyprus. *Frontiers in Psychology*, 13(1017747):1-17. https://doi.org/10.3389/fpsyg.2022.1017747.

Iyus S.M. & Bustami, Y. 2022. Critical thinking skills on human digestive system materials: contextual teaching and learning based gender. *Turkish Journal of Computer and Mathematics Education*, 13(1):30–37. https://www.turcomat.org/index.php/turkbilmat/article/view/11925/8731.

Jenkins, S.H. 2015. *Tools for Critical Thinking in Biology.* USA: Oxford University Press.

Kemdikbud. 2019. *Capaian Nilai Hasil Ujian Nasional Tahun 2018/2019*. Jakarta: Pusat Penilaian Pendidikan Balitbang Kemdikbud.

Kemendikbudristek. 2022. *Peraturan menteri pendidikan kebudayaan riset dan teknologi tentang standar proses pada pendidikan usia dini, jenjang pendidikan dasar dan jenjang pendidikan menengah*. Jakarta: Berita Negara Republik Indonesia.

Kemdikbud. 2019. *Pendidikan di Indonesia belajar dari hasil PISA 2018*. Jakarta: Pusat Penilaian Pendidikan Balitbang Kemdikbud.

Kemendikbudristek. 2022. *Rapor Pendidikan Publik 2022*. Jakarta: Pusat Asesmen Pendidikan Badan Standar, Kurikulum, dan Asesmen Pendidikan.

Khalil, M., Lazarowitz, R., & Hertz-Lazarowitz, R. 2014. Biology high school science curricula for the 21st century. *Creative Education*, 5(16):1464–1478. https://doi.org/10.4236/ce.2014.516164.

Khanal, B. 2016. Learning strategies used by urban and rural school students in mathematics. *International Journal of Education and Multidisciplinary Studies*, 4(3):387-396. https://doi.org/10.21013/jems.v4.n3.p5.

Knoblauch, D. & Chase, M.A. 2015. Rural, suburban, and urban schools: The impact of school setting onthe efficacy beliefs and attributions of student teachers. *Teaching and Teacher Education*, 45:114-114. https://doi.org/10.1016/j.tate.2014.10.001.

Kocak, O., Coban, M., Aydin, A., & Cakmak, N. 2021. The mediating role of critical thinking and cooperativity in the 21st century skills of higher education students. *Thinking Skills and Creativity*, 42:1–20. https://doi.org/10.1016/j.tsc.2021.100967.

Kudus, I. 2022. The correlation between critical thinking skills with student metacognitive skills on ecosystem material. *Journal of Biology Education*, 5(2):25–39. DOI : 10.21043/jobe.v5i2.12336

Kurniawan, D.A., Wirayuda, R.P., Putri, W.A., Febri, E., Rini, S., & Ratnawati, T. 2023. Impact of science process skills on thinking skills in rural and urban schools. *International Journal of Instruction*, 16(2):803–822. https://doi.org/10.15294/jpii.v9i4.24139.

Liu, N.Y., Hsu, W.Y., Hung, C.A., Wu, P.L., & Pai, H.C. 2019. The effect of gender role orientation on student nurses' caring behaviour and critical thinking. *International Journal of Nursing Studies*, 89:18–23. https://doi.org/10.1016/j.ijnurstu.2018.09.005.

Liyanto, M.S., Disman, D., & Dahlan, D. 2021. Identifikasi perbedaan keterampilan berpikir kritis ditinjau dari motivasi belajar peserta didik. *Socia: Jurnal Ilmu-Ilmu Sosial*, 17(1):91–98. https://doi.org/10.21831/socia.v17i1.34111.

Cohen, L., Morrison, L., Manion, L., & Keith. 2011. *Research Methods in Education*. USA: Routledge.

Lun, V.M.C., Yeung, J.C., & Ku, K.Y.L. 2023. Effects of mood on critical thinking. *Thinking Skills and Creativity*, 47:1-20. https://doi.org/10.1016/j.tsc.2023.101247.

Mahanal, S., Tendrita, M., Ramadhan, F., Ismirawati, N., & Zubaidah, S. 2019. The analysis of students' critical thinking skills on biology subject. *Anatolian Journal of Education*, 2(2):1-14. https://doi.org/10.29333/aje.2017.223a.

Mardonov, Z. 2019. The importance of biological education at school. *European Journal of Research and Reflection in Educational Sciences*, 7(12):909–912. https://www.idpublications.org/wp-content/uploads/2019/11/Full-Paper-historical-foundations-for-the-creation-of-textbooks-in-secondary-school.pdf.

Mawaddah, Ahmad, A., & Duskri, M. 2018. Gender differences of mathematical critical thinking skills of secondary school students. *Journal of Physics: Conference Series*, 1088:1-7. https://doi.org/10.1088/1742-6596/1088/1/012054.

McCracken, J.D. & Barcinas, J.D. 1991. Differences between rural and urban schools, student characteristics, and student aspirations in Ohio. *Journal of Research in Rural Education*, 7(2):29-40. http://www.jrre.psu.edu/articles/v7,n2,p29-40,McCracken.pdf.

Mukaka, M.M. 2012. Statistics corner: A guide to appropriate use of correlation coefficient in medical research. *Malawi Medical Journal*, 24(3):69–71. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3576830/pdf/MMJ2403-0069.pdf.

Munawarah, L., Soendjoto, M.A., & Halang, B. 2018. Critical thinking sability of biology education students through environmental toxicology's problem solving. *Edusains*, 10(1):1–7. https://doi.org/10.15408/es.v10i1.6656.

Muwaffiq, M.N., Fatah, H.M., & Ibrahim. 2020. Hubungan antara motivasi belajar dengan kemampuan berfikir kritis siswa kelas IX Madrasah Tsanawiyah (MTs). *Jurnal Program Studi Pendidikan Matematika*, 11(1):19–28. https://www.journal.unrika.ac.id/index.php/jurnalphythagoras/article/view/3615.

Nugroho, A.T., Karyanto, P., & Sugiharto, B. 2022. Profile of critical thinking ability of high school students on animalia material during hybrid learning in the pandemic era. *Jurnal Penelitian Pendidikan IPA*, 8(6):2635–2640. https://doi.org/10.29303/jppipa.v8i6.1809.

Nurse, P. 2016. The importance of biology education. *Journal of Biological Education*, 50(1):7–9. http://dx.doi.org/10.1080/00219266.2016.1140985.

OECD. 2013. *What makes urban schools different?* PISA: OECD Publishing.

Patricia, L. 2017. *Research Design: Quantitative, Qualitative, Mixed Methods, Arts-Based, and Community-Based Participatory Research Approaches*. New York: A Division of Guilford.

Perdana, R., Budiyono, Sajidan, & Sukarmin. 2019. Analysis of student critical and creative thinking (CCT) skills on chemistry: a study of gender differences. *Journal of Educational and Social Research*, 9(4):43–52. https://doi.org/10.2478/jesr-2019-0053.

Pislaengam, K. 2018. An analysis of critical thinking skills in general education course. *Advances in Social Sciences Research Journal*, 5(6):54–61. https://doi.org/10.14738/assrj.56.4615.

Prasadh, A.T.J. & Titus, D.S.V. 2021. A study of critical thinking among higher secondary students. *International Journal of Life Skills Education*, 6(11):951–952. https://ijlse.com/wp-content/uploads/2021/08/2.0-Journal_Vol2_Number1_January-2016.pdf.

Rahman, A. 2018. Profil kemampuan berpikir kritis dan kemampuan metakognitif siswa berdasarkan jenis kelamin. *Jurnal Pendidikan Biologi*, 10(1):28-43. https://doi.org/10.17977/um052v10i1p28-43.

Reynders, G., Lantz, J., Ruder, S.M., Stanford, C.L., & Cole, R.S. 2020. Rubrics to assess critical thinking and information processing in undergraduate STEM courses. *International Journal of STEM Education*, 7(1):1-15. https://doi.org/10.1186/s40594-020-00208-5

Sahanowas & Halder, S. 2020. Critical thinking disposition of undergraduate students in relation to emotional intelligence: Gender as a moderator. *Heliyon*, 6(11):1-10. https://doi.org/10.1016/j.heliyon.2020.e05477.

Sahin, M.C. 2009. Instructional design principles for 21st century learning skills. *Procedia Social and Behavioral Sciences*, 1(1):1464–1468. https://doi.org/10.1016/j.sbspro. 2009.01.258.

Saputri, A.C., Sajidan, S., & Rinanto, Y. 2018. Critical thinking skills profile of senior high school students in Biology learning. *Journal of Physics: Conference Series*, 1006(1):1-6. https://doi.org/10.1088/1742-6596/1006/1/012002.

Sari, R.I., Karyanto, P., & Muzzazinah, M. 2018. Analysis of critical thinking skill based on the difference of gender at SMA Surakarta in biology subject. *Advances in Social Science, Education and Humanities Research (ASSEHR) 5th Asia-Pacific Education Conference (AECON 2018), 267*:165–167. https://doi.org/10.2991/aecon-18.2018.31.

Sari, R.M., Sumarmi, Astina, K.I., Utomo, D.H., & Ridhwan. 2019. Measuring students scientific learning perception and critical thinking skill using paper-based testing: School and gender differences. *International Journal of Emerging Technologies in Learning*, 14(19):132–149. https://doi.org/10.3991/ijet.v14i19.10968.

Schleicher, A. 2012. *Preparing Teachers and Developing School Leaders for the 21st Century*. Paris: OECD Publishing.

Schober, P. & Schwarte, L.A. 2018. Correlation coefficients: Appropriate use and interpretation. *Anesthesia and Analgesia*, 126(5):1763–1768. https://doi.org/10. 1213/ANE.0000000000002864.

Seibert, S.A. 2022. Validated instructional resource to engage nursing students in critical thinking. *Teaching and Learning in Nursing*, 17(3):263–266. https://doi.org/ 10.1016/j.teln.2022.01.011.

Shreve, J. 2021. *Differences in Education in Urban and Rural Areas Running Head : Urban and Rural Education*. Ohio: University of Akron Press.

Shubina, I. & Kulakli, A. 2019. Critical Thinking, Creativity and Gender Differences for Knowledge Generation in Education. *Literacy Information and Computer Education Journal*, 10(1):3086–3093. https://doi.org/10.20533/licej.2040.2589.2019.0405.

Sturner, K.K., Bishop, P., & Lenhart, S.M. 2017. Key skills for the 21st century: an evidence-based review. *Education Future Frontiers*, 27(3):370-388. https://doi.org/10.1080/10511970.2016.1188432.

Sugiyono. 2017. *Statistika untuk Penelitian*. Bandung: Alfabeta.

Sun, H., Xie, Y., & Lavonen, J. 2022. Exploring the structure of students ' scientific higher order thinking in science education. *Thinking Skills and Creativity*, 43:1-13. https://doi.org/10.1016/j.tsc.2022.100999.

Sun, X., Wang, Z.J., Li, Y.Y., Chan, K.Q., Miao, X.Y., Zhao, S., Wu, Y.Q., Li, Z., & Wu, B. M. 2022. Trends of college students' mental health from 2005 to 2019 and its rural–urban disparities in China. *Journal of Affective Disorders*, 302:160–169. https://doi.org/10.1016/j.jad.2022.01.042.

Supriyati, H. & Djukri. 2021. High school students' critical thinking skills during online learning in biology: gender perspective. *Proceedings of the 6th International Seminar on Science Education (ISSE 2020)*, 541:117–122. https://doi.org/10.2991/assehr.k.210326.016.

Tamam, B., Corebima, A.D., Zubaidah, S., & Suarsini, E. 2021. An investigation of rural-urban students' critical thinking in biology across gender. *Pedagogika*, 142(2):200–217. https://doi.org/10.15823/p.2021.142.11.

Tambunan, E.D., Restutuati, M., & Silitonga, M. 2018. An analysis of students Critical Thinking Skills for the Topic of Biotechnology of Senior High Schols in Labuhanbatu Utara Regency. *3rd Annual International Seminar on Transformative Education and Educational Leadership (AISTEEL 2018)*, 200:91–99. https://doi.org/10.2991/ aisteel-18.2018.19.

Villacorta, T.Á., Leon, G.R., Martínez, R.S., & Rodríguez, S.C. 2017. Knowledge of chagas disease among elementary school students in two areas rural and urban of the Southern Huasteca of San Luis Potosi, Mexico. *Procedia-Social and Behavioral Sciences*, 237:1254–1259. https://doi.org/10.1016/j.sbspro.2017.02.202.

Tanti, Kurniawan, D.A., Kuswanto, Utami, W., & Wardhana, I. 2020. Science process skills and critical thinking in science: Urban and rural disparity. *Jurnal Pendidikan IPA Indonesia*, 9(4):489–498. https://doi.org/10.15294/jpii.v9i4.24139.

Thongnuypram, C. 2013. Factor influencing the critical thinking of teacher students studying at the faculty of education in Suratthani Rajabhat University. *Procedia-Social and Behavioral Sciences*, 103:386–391. https://doi.org/10.1016/j.sbspro. 2013.10.349.

Turan, O., Broutin, M.S.T., & Ezentas, R. 2022. Analytical tinking skills of high-school students living in rural and urban areas. *Istanbul: Egitim Yeyinevi*. https://doi.org/10.1016/j.sbspro.2013.10.349.

Ugwuozor, F.O., Ede, M.O., Ifelunni, O.C., & Abiogu, G.C. 2020. Teachers' demographic variables as predictors of critical thinking skills of school children: implications for school counselling. *Global Journal of Health Science*, 12(5):91-102. https://doi.org/10.5539/gjhs.v12n5p91.

Ulfah, S., & Nurmaliah, C. 2020. The implementation of science-based module in improving students' critical thinking skills and learning outcomes in state senior high school in Southwest Aceh District. *IJAEDU- International E-Journal of Advances in Education*, 6(17):203–209. https://doi.org/10.18768/ijaedu.789407.

Wagh, R. 2022. Comparison between learning of rural and urban students. *International Journal of Scientific Development and Research (IJSDR)*, 7(6):37–41. https://www.ijsdr.org/papers/IJSDR2206006.pdf.

Wibowo, Y.G. & Sadikin, A. 2019. Biology in the 21st-Century: Transformation in biology science and education in supporting the sustainable development goals. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, 5(2):285–296. https://doi.org/10.22219/jpbi. v5i2.7956.