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Correlation between Students' Biology Literacy and Belief in Science at Senior High School

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Abstract
The COVID-19 pandemic that has hit the world including Indonesia, has had an impact on various aspects of life, one of which is education which has been transformed into courageous learning. Learning is supported by internet technology, but a lot of information is not in line with science. This can lead someone to easily reject the truth of science. As a student, you must have an attitude of trust in science, because in essence science prohibits processes, products, attitudes and technology. One way to select information that is not in line with science, especially in the field of biology, is through biological literacy. This study aims to analyze the relationship between biological literacy and scientific beliefs of Senior High School 1 Batu students. This type of research used survey research using a nominal biological literacy instrument totaling 20 question items, a functional biology literacy instrument totaling 20 question items, and a belief in science instrument totaling 16 question items. This study involved 247 students with a research time of 5 May 2023 – 23 May 2023. The independent variable in this study was biological literacy, while the dependent variable was belief in science. The sampling technique used is cluster random sampling. The data that has been collected is tested using multiple linear regression analysis. Obtained buying and selling regression y = 33.510 + 0.112x1 + 0.280x2. Based on these results, it can be written that the student biology literacy variable can be considered as a predictor that can predict the variable of trust in science students. However, the variable functional biological literacy is a greater predictor than nominal biological literacy.

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1. Introduction

The COVID-19 pandemic that has hit the world including Indonesia, has had an impact on various aspects of life, one of which is education (Basar, 2021) [6]. Learning activities must be carried out even in a pandemic outbreak situation. Educational activities that were initially carried out face-to-face in class have been changed to learning using online methods (Surani & Hamidah, 2020; Winata, Koko Adya; Zaqiah, 2019) [30, 36]. Online learning is supported by technological developments in the form of the internet which functions to provide convenience and flexibility in exploring knowledge. With the internet, students are getting more and more information and knowledge (Sasmita, 2020) [26]. However, on the other hand a lot of information from the internet is wrong or not in line with science (Bafadhal & Santoso, 2020) [4]. This can lead someone to easily reject scientific truths.

As a student, you must have an attitude of belief in science. Science is one of the subjects that plays an important role in education, with science being a provision for students to face challenges in the global era (Yuliati, 2017) [38]. Learning science will direct students to have the character of curiosity, think logically, critically, creatively and innovatively, be honest, live

healthy, be confident, respect diversity, be disciplined, be independent, be responsible, care for the environment and love science (Chusani, 2013) [7]. In essence, science (biology) contains 4 elements, including: process (scientific process), product (scientific knowledge), attitude (scientific attitudes), and technology. By believing in science, students can have the ability to describe natural phenomena so that scientific products are obtained in the form of facts, principles, laws, and theories (Sudarisman, 2015) [29]. With these elements, students are expected to have scientific confidence by following the development of science. Students or students are part of the community who develop their potential through the learning process (Ramli, 2015) [23]. Public trust in science during the pandemic has decreased. This is because it is easier for people to get information in the digital world. Most of this information discusses pandemics, both scientific discussions and those that conflict with biology. A lot of incorrect information is related to the origin of the virus early in the pandemic (Saputra, 2020) [25]. Many people still think that COVID-19 is manipulated and considers it a conspiracy (Irwans *et al*., 2021) [13]. Furthermore, in the midst of a pandemic, there is incorrect information regarding health protocols (prokes). This happened because the community believed that "COVID-19 doesn't exist", resulting in people being ignorant of health protocols which had an impact on delaying the handling of COVID-19(Balatif, 2021) [5]. In addition, towards the end of the pandemic, there is incorrect information about vaccines. This has led to an anti-vaccine society, namely people who do not agree with the use of vaccines and some even go so far as to spread incorrect information about vaccines and the news is believed by some people (Fitriarti, 2019) [10].

The news includes socio-scientific issues related to biology. Based on this description, many people reject the truth of biology. This is due to the large amount of information on the internet that is not in line with biology. People often believe unscientific information. Supposedly, as part of an urban community that is close to the reach of access to information development (the internet), they must have self-control in receiving information so they can distinguish between factual and hoax information. (Lisdiana & Dwi Jayanti, 2022; Prasanti, 2017) [16, 21]. In response to this, a balance is needed between information on social media and scientific literacy among the public (Linzonia & Supriyono, 2021) [15].

One way to select information that is not in line with science, especially in the field of biology, is through biological literacy. Biological literacy is a branch of scientific literacy which refers to biology subjects (Onel & Sule, 2019; Vonny *et al*., 2021) [20, 34]. Through biological literacy a person is expected to have the ability to use scientific inquiry to understand and recognize biological issues in society, so that they can integrate these ideas into decision making and communicate the results to others. (McFarlane, 2013) [18]. There are four levels in biological literacy, including: nominal, functional, structural, and multidimensional (Uno & Bybee, 1994) [33].

Based on previous research regarding the identification of the predictive power of biological literacy and attitudes towards biology in high school students' academic achievement, it was found that there was a positive correlation between attitudes towards biology literacy and student academic achievement. (Onel & Sule, 2019; Semilarski, 2022) [20, 27].

Research on students' scientific literacy in biology subjects found that students' biological science literacy skills were still relatively low (Adnan *et al*., 2021) [1]. Research on the concept of the term biological literacy and the theoretical concept of biological literacy was carried out by Semilarski & Laius (2021) [28] the results show that biological literacy is defined as an interdisciplinary concept, including biology knowledge and core concepts, covering socioscientific issues that focus on biological issues, positive values and attitudes towards biology, biology-related careers awareness that all together improve skills student cognitive. The concept of biological literacy refers to the dimensions of biological literacy developed by Uno & Bybee (1994) [33].

In addition, research on the assessment of the biology literacy level of high school students was carried out by Anakara (2021) [3] shows that the nominal level of biological literacy is higher than the multidimensional level. Unlike the results of research Mahardika *et al* (2016) [17] regarding the exploration of early biological literacy abilities of high school students, it was found that the biological literacy level at the functional level was higher than the other three levels. The results of students' abilities at the biology literacy level are influenced by students' understanding of the biology learning process. In line with research conducted by Suwono *et al* (2017) [31] that learning biology based on sociobiological cases can increase students' biology literacy. In addition, it is also in line with research Allum *et al* (2014) [2] get the result that there is a positive relationship between scientific knowledge and belief in science.

Research on the development and validation of scientific trust instruments and scientists is carried out by Nadelson *et al* (2014) [19]. In addition, research on the development and validation of the scientific credibility scale was carried out by Hartman *et al* (2017) [11] and belief evaluation research on a scientific scale has been carried out by Dagnall *et al* (2019) [8]. The results of this study were used to determine the relationship between participants' level of trust based on context, investigative lens, participant characteristics, and other variables as an effort made to determine how someone's belief in science.

Based on previous studies, there has been no research on the relationship between biological literacy and students' belief in science. Biological literacy research at the high school level aims to develop biological literacy, especially in a scientific context. Research on high school biology literacy in Indonesia was conducted by Mahardika *et al* (2016) and there has been no similar study in subsequent years. In Indonesia, this research is new research and is rarely researched, so the research is carried out in stages. The level developed is at the nominal and functional levels. In addition, all research instruments were tested for validation. The results of this study are expected to overcome the problem of knowing the relationship between biological literacy and students' belief in science.

2. Method

This study used a survey method with a quantitative approach to determine the relationship between biology literacy and students' belief in science. This research was conducted at Senior High School 1 Batu. Respondents in this study consisted of 247 students. Respondents were taken using a random sampling technique. Details of the respondent's demographic data can be seen in Table 1.

Table 1: Respondent Demographic Data

Group	Criteria	n (%)
Gender	Male	74 (29,96)
	Female	173 (70,04)
Age	15 years	11 (4,45)
	16 years	80 (32,39)
	17 years	86 (34,82)
	18 years	65 (26,32)
	19 years	5 (2,02)
Class	X	82 (33.20)
	XI MIPA	82 (33,20)
	XII MIPA	83 (33,60)

The number of male respondents was 74 students and the number of female respondents was 173 students. There is a difference in the age of each respondent. Most respondents were from 17 years old, namely 86 students, 80 students aged 16 years, 65 students aged 18, 11 students aged 15 years, and the least number of respondents from 19 years old were 5 students.

Data collection was carried out using three instruments, namely 1) 20 items of nominal biological literacy questions that were valid and reliable with the validity results showing the p-value for each item < 0,05 and Cronbach's Alpha 0,904, 2) 20 items functional biology literacy items that were valid and reliable with the results of person validation, obtained a p-value for each question item <0,050 and Cronbach's Alpha of 0,73, 3) 16 items of valid and reliable belief in science with the results of person validity, obtained a p-value for each question item < 0,050 and Cronbach's Alpha of 0,801.

The data analysis technique used is multiple linear regression test. However, beforehand, a prerequisite assumption test was carried out in the form of a linearity test, homoscedasticity test, normality test, and multicollinearity test.

3. Result and Discussion

The nominal biological literacy ability of SMA Negeri 1 Batu students can be seen in Table 2.

Table 2: Data Distributing Respond Literati Biology Nominal

Item Question	Student response n (%)			
	0	1	2	3
1	6 (2,43)	40 (16,19)	100 (40,49)	101 (40,89)
2	84 (34,01)	72 (29,15)	58 (23,48)	33 (13,36)
3	0 (0,00)	5 (2,02)	72 (29,15)	170 (68,83)
4	0 (0,00)	3 (1,21)	42 (17,00)	202 (81,78)
5	0 (0,00)	2 (0,81)	39 (15,79)	206 (83,40)
6	9 (3,64)	28 (11,34)	57 (23,08)	153 (61,94)
7	0 (0,00)	1 (0,40)	22 (8,91)	224 (90,69)
8	2 (0,81)	6 (2,43)	48 (19,43)	191 (77,33)
9	4 (1,62)	7 (2,83)	66 (26,72)	170 (68,83)
10	0 (0,00)	1 (0,40)	29 (11,74)	217 (87,85)
11	1 (0,40)	5 (2,02)	67 (27,13)	174 (70,45)
12	72 (29,15)	55 (22,27)	55 (22,27)	65 (26,32)
13	10 (4,05)	36 (14,57)	83 (33,60)	118 (47,77)
14	0 (0,00)	1 (0,40)	46 (18,62)	200 (80,97)
15	0 (0,00)	0 (0,00)	50 (20,24)	197 (79,76)
16	8 (3,24)	39 (15,79)	89 (36,03)	111 (44,94)
17	0 (0,00)	5 (2,02)	70 (28,34)	172 (69,64)
18	0 (0,00)	0 (0,00)	31 (12,55)	216 (87,45)
19	0 (0,00)	1 (0,40)	39 (15,79)	207 (83,81)
20	0 (0,00)	2 (0,81)	32 (12,96)	213 (86,23)
Total	196 (3,97)	309 (6,26)	1095 (22,17	3340 (67,61)

Information:
Numbers 1-20 = Question items
0 = never heard of
1 = have heard but do not know the meaning
2 = have heard and seem to know the meaning
3 = have heard and are sure to understand the meaning

Based on the results of the data analysis that has been done, there are interesting findings to discuss. Nominal biology literacy items ask about familiarity with biology terms. There are question items that include the lowest literacy, namely item number 2 "infertility", item number 6 "ovum", and item number 12 "heredity". These items are included in the topics of reproductive technology and hereditary diseases. This is possible because the material on reproduction and hereditary diseases is classified as material that is considered difficult by students because there are stages of reproduction and terms that are difficult to understand. (Yulia, 2021) [37]. In addition, the material also contains abstract concepts and students are required to have a fairly high conceptual understanding (Djamahar *et al.*, 2021) [9].

Question items that include the best literacy are item number 7 "ecosystem", item number 10 "global warming", and item number 18 "pollution". These items are included in the topic of environmental issues. This item includes the best literacy because the material on environmental issues includes material that is often taught at the school level so that students are more familiar with these biology terms (Santika *et al.*, 2022) [24].

Table 3: Data on Functional Biology Literacy Response Distribution

Item Question	Student response n (%)		
	0	1	2
1	19 (7,69)	102 (41,30)	126 (51,01)
2*	113 (45,75)	11 (4,45)	123 (49,80)
3	22 (8,91)	18 (7,29)	207 (83,81)
4*	61 (24,70)	18 (7,29)	168 (68,02)
5	24 (9,72)	28 (11,34)	195 (78,95)
6*	111 (44,94)	55 (22,27)	81 (32,79)
7*	54 (21,86)	21 (8,50)	172 (69,64)
8*	156 (63,16)	9 (3,64)	82 (33,20)
9	8 (3,24)	5 (2,02)	234 (94,74)
10	8 (3,24)	32 (12,96)	207 (83,81)
11*	44 (17,81)	16 (6,48)	187 (75,71)
12	12 (4,86)	7 (2,83)	228 (92,31)
13*	48 (19,43)	28 (11,34)	171 (69,23)
14	10 (4,05)	102 (41,30)	135 (54,66)
15	21 (8,50)	51 (20,65)	175 (70,85)
16*	100 (40,49)	41 (16,60)	106 (42,91)
17	30 (12,15)	35 (14,17)	182 (73,68)
18	13 (5,26)	10 (4,05)	224 (90,69)
19*	124 (50,20)	18 (7,29)	105 (42,51)
20	233 (94,33)	10 (4,05)	4 (1,62)
Total	1211 (24,51)	617 (12,49)	3112 (63,00)

Information:
* = Negative statement
Numbers 1-20 = Question items

Positive Statement	Negative Statement
0 = Inaccurate	0 = Exactly
1 = Don't know	1 = Don't know
2 = Exactly	2 = Inaccurate

Functional biology literacy which has indicators students can remember and understand the definitions of biological terms. There are question items that include the lowest literacy, namely item number 8 "Vaccines are drugs used to treat certain diseases", item number 19 "Virus is a type of fungus that can grow and reproduce in the human body", and item number 20 "Ovum or egg cells are female reproductive cells that can be fertilized by sperm. These items cover the topics of infectious diseases and reproductive technologies. This is possible because reproduction material is classified as material that is considered difficult by students because there are stages of reproduction and terms that are difficult to understand (Yulia, 2021) [37]. Reproduction technology question items that asked for definitions of vaccines and viruses were also answered incorrectly by students because they contained abstract concepts and students were required to be careful in understanding their meanings.

The question item that includes the best literacy is item number 9 "Pollution is the entry of foreign substances or energy into the environment which can damage the balance of the ecosystem and endanger human health", item number 12 "The process of reproduction in humans is the process of forming new individuals from a combination of cells male and female genital organs", and item number 18 "immunity is the body's protective system that works to fight infection". These items include topics on environmental issues, reproductive technology, and infectious diseases. Based on nominal biological literacy, environmental problem material is also classified as good literacy. One example is in item number 9 regarding the definition of pollution which is in line with Pratiwi (2020) [22] states that pollution is the entry or entry of living things, energy substances, and or other components into the environment by human activities or by natural processes. However, reproductive technology materials and infectious diseases have results that are inversely proportional to nominal biological literacy. This is because functional literacy in question items is given a definition for each term so that students can understand how the term means.

Table 4: Data on the Distribution of Belief Responses to Science

Item Question	0 n (%)	1 n (%)	2 n (%)	3 n (%)	4 n (%)
1	0 (0.00)	2 (0.81)	3 (1.21)	80 (32.39)	162 (65.59)
2	0 (0.00)	2 (0.81)	10 (4.05)	110 (44.53)	125 (50.61)
3	0 (0.00)	1 (0.40)	8 (3.24)	97 (39.27)	141 (57.09)
4*	34 (13.77)	58 (23.48)	69 (27.94)	71 (28.74)	15 (6.07)
5*	21 (8.50)	56 (22.67)	111 (44.94)	49 (19.84)	10 (4.05)
6*	35 (14.17)	69 (27.94)	90 (36.44)	45 (18.22)	8 (3.24)
7	2 (0.81)	25 (10.12)	52 (21.05)	129 (52.23)	39 (15.79)
8	1 (0.40)	21 (8.50)	63 (25.52)	103 (41.70)	59 (23.89)
9*	15 (6.07)	44 (17.81)	57 (23.08)	87 (35.22)	44 (17.81)
10*	14 (5.67)	30 (12.15)	81 (32.79)	78 (31.58)	44 (17.81)
11*	32 (12.96)	49 (19.84)	88 (35.63)	49 (19.84)	29 (11.74)
12*	19 (7.69)	57 (23.08)	96 (38.87)	67 (27.13)	8 (4.24)
13*	8 (3.24)	34 (13.77)	70 (28.34)	117 (47.37)	18 (7.29)
14*	14 (5.67)	44 (17.81)	70 (28.34)	86 (34.82)	33 (13.36)
15*	32 (12.96)	72 (29.15)	69 (27.94)	64 (25.91)	10 (4.05)
16	3 (1.21)	3 (1.21)	46 (18.62)	126 (51.01)	69 (27.94)
Total	230 (5.82)	567 (14.35)	983 (24.87)	1358 (34.36)	814 (20.60)

Information:
* = Negative statement
Numbers 1-16 = Question items

Positive Statement	Negative Statement
0 = Strongly disagree	0 = Strongly agree
1 = Disagree	1 = Somewhat agree
2 = Undecided	2 = Undecided
3 = Somewhat agree	3 = Disagree
4 = Strongly agree	4 = Strongly disagree

Belief in science which has indicators students can trust, believe, identify scientific procedures and findings as methods and knowledge that can be accepted for truth. There are question items that include low scientific trust, namely item number 4 "Scientists usually ignore evidence that contradicts their research", item number 6 "Scientists deliberately keep their work secret", and item number 11 "Today's scientists will sacrifice the welfare of others to advance their research". These items are included in the indicators that students are able to identify the character of a scientist. This is possible because students are less able to identify the characteristics of scientists, including honest, objective, responsible for tasks, diligent, and tolerant (Widodo, 2013) [35].

The question items that include the best belief in science are item number 1 "Science provides accurate information about nature", item number 2 "Scientific truth can be proven with certainty", and item number 3 "The scientific method is a procedure that can produce findings that can be trusted". These items are included in indicators of believing in the certainty of science-based information. This is because learning at school has been balanced with direct practice such as in biology subjects. Practicums provide learning experiences for students so they can interact with material or with secondary data sources to observe and understand learning concepts (Ulfa, 2016) [32]. Thus, students are able to understand the material and can also directly prove the truth of the material obtained.

Based on the results of multiple regression analysis tests, it can be seen that there is an interaction between the dependent variable (belief in science) and the independent variable (biological literacy). The interaction is that there is a relationship between the dependent variable and the independent variable. Each value of biological literacy is able to predict the value of a student's belief in science. the prediction is written in the regression equation y = 33,510 +

0,112x1 + 0,280x2, where the y variable in the equation represents belief in science and the x variable represents biological literacy. If x is substituted with a value it will have an impact on y and the results will show a direct proportion (a high x value has an impact on a high y value, and vice versa). So that the regression equation can be explained that an increase in one nominal biological literacy score will increase the trust score in science by 0,112. Meanwhile, an increase in one functional biology literacy score will increase the trust score in science by 0,280.

Based on the regression equation, it can be seen that functional biology literacy can be a greater predictor than nominal biology literacy. This is in accordance with the theory (Uno & Bybee, 1994) [33] that functional biology literacy has a higher level than the functional level. This is because functional biology literacy has characteristics that are higher in the level of understanding of biological concepts. Therefore, it can be seen that students have good abilities in biology literacy. Therefore, biological literacy can be used as a predictor of science confidence in SMA Negeri 1 Batu students.

In the world of education, it is necessary for teachers and students to know that belief in science is a person's belief that scientific procedures and findings are methods and knowledge that can be accepted for truth. (Dagnall *et al*., 2019; Hidayat, 2007) [8, 12]. Science is defined as knowledge about a field that is arranged systematically according to certain methods that can explain certain phenomena in the field of knowledge with coherent, empirical, measurable and verifiable characteristics. Therefore, with science one is expected to be able to explain a symptom or natural phenomenon, so that it is useful for life (Lailiyah, 2018) [14]. Teaching science serves to educate citizens to be literate in science. One of the subjects related to science is biology. So, to empower science abilities, including students' confidence in science, empowerment in the field of biology is needed. Therefore, it can be seen that the ability of students' biology literacy will affect the level of confidence in students' science. This is in line with the statement Onel & Sule (2019) [20]; Vonny *et al* (2021) [34] that biological literacy is a branch of scientific literacy that refers to biology subjects.

This is supported by research Semilarski & Laius (2021) [28] regarding the concept of the term biological literacy and the theoretical concept of literacy, it was found that biological literacy is defined as an interdisciplinary concept, including biological knowledge and core concepts, covering socioscientific issues that focus on biology issues, positive values and attitudes towards biology, related careers awareness biology that all together enhance students' cognitive skills. This indicates that biological literacy influences students' knowledge and attitudes regarding sociosynthetic issues involving students' belief in science. In terms of knowledge it refers to students' trust in scientific sources and information, while in terms of attitude it refers to belief in the character of scientists.

In addition, research on the assessment of the biology literacy level of high school students was carried out by Anakara (2021) [3] shows that the nominal level of biological literacy is higher than the multidimensional level. This is in accordance with the results of this study because of the two questionnaire levels (nominal level and functional level) that have been filled in by respondents, the nominal level has the highest average score of 84.47 while the average functional level score is 69.46. However, it is necessary to carry out a regression test to find out whether nominal and functional biological literacy can be used as a predictor of belief in science. Based on the results of the regression test, functional biology literacy is the greatest predictor of nominal biology literacy. The results of students' abilities at the biology literacy level are influenced by students' understanding of the biology learning process. According to Suwono *et al* (2017) [31] learning biology based on sociobiological cases can increase students' biology literacy. In addition, it is also in line with research Allum *et al* (2014) [2] get the result that there is a positive relationship between scientific knowledge and belief in science. Therefore, the questionnaire in this study uses statements of sociobiological issues.

Trust in student science can be increased through biological literacy. However, teachers must pay attention to two factors, namely understanding knowledge and understanding sociobiological content in biology learning (Suwono *et al*., 2017) [31]. Biology content is inseparable from science because biological literacy is a branch of scientific literacy (Onel & Sule, 2019) [20]. Based on these things, it can be seen that belief in science has many indicators related to students' biology literacy. So, the higher the ability of biological literacy will lead to a higher trust in science in students and vice versa.

4. Conclusion

Based on the results of the analysis and discussion, it can be concluded that research on the relationship between biology iteration and students' belief in science at Senior High School 1 Batu is that there is a positive relationship between biological literacy and students' confidence in science at Senior High School 1 Batu. This has been shown by the results of multiple linear regression tests with a significance value of less than 0,001, so the hypothesis is accepted. This is also reinforced by the regression equation that appears, namely y = 33,510 + 0,112x1 + 0,280x2. In accordance with this equation, it can be seen that an increase in one nominal biological literacy score will increase the score of trust in science by 0,112. Meanwhile, an increase in one functional biology literacy score will increase the trust score in science by 0,280. Thus, the student's biology literacy variable can be considered as a predictor that can predict from the student's belief in science variable. However, the variable functional biology literacy is a greater predictor than nominal biology literacy.

5. Thank-You Note

Thank you to Senior High School 1 Batu for being the research location.

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