Effectiveness of Science Learning Model Containing Balinese Local Wisdom in Improving Character and Science Literacy of Junior High School Students

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Abstract

The current situation is the low character of students, so brawls and violence often occur in various layers of society. The present study is aimed at analyzing the effectiveness of the science learning model in improving the character and scientific literacy of junior high school students. The research is a quasi-experimental design in the form of a posttest-only control design. The study sample was 158 people. A questionnaire and test were used for the character and scientific literacy variable data collection. Descriptive analysis and inferential analysis were used to analyze the post-test data. The descriptive analysis involved the mean, standard deviation, and variance. Inferential statistical analysis was done with the MANOVA test. The analysis results showed that the F value for Pillae Trace, Wilk Lambda, Hotelling Trace, and Roy's Largest Root had significantly less than 0.001, which means all are significant. Therefore, the study indicates that the science learning model containing Balinese local wisdom is effective on character and scientific literacy. Thus, this learning is recommended as a solution that can be used as an innovative learning model.

Keywords: Character, Science learning model containing balinese local wisdom, Science literacy.

DOI: 10.53894/ijirss.v5i4.750
Funding: This study received no specific financial support.
History: Received: 3 August 2022/Revised: 19 September 2022/Accepted: 5 October 2022/Published: 14 October 2022
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Authors’ Contributions: All authors contributed equally to the conception and design of the study.
Competing Interests: The authors declare that they have no competing interests.
Transparency: The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained.
Ethical: This study followed all ethical practices during writing.
Publisher: Innovative Research Publishing

1. Introduction

The era of Disruption has entered half new in the development of knowledge and technology which has penetrated the education sector. Stakeholders who are interested in environmental education are expected to be capable of responding positively to the changes that are happening in the era of industrial revolution 4.0 [1-3]. Education must be reorganized to reach the goal of producing thinkers who are capable of building a knowledge-based social and economic order in the 21st century [4, 5]. This condition certainly requires students to have revolution 4.0 skills. The skills of 4.0 include scientific
and metacognitive skills, the ability to think critically and creatively, and the ability to communicate and collaborate effectively [6-8]. The skills must be possessed by the students. The possession of these skills will enable students to solve problems they encounter in their daily life [9-11]. In addition to these skills, it is also necessary to develop new literacy which includes data literacy, technological literacy, and human literacy [12, 13]. Part of data literacy is scientific literacy which is the main goal of science education about scientific concepts and principles, scientific laws and theories, and inquiry skills.

Science literacy will become an experience and key to success in education science [14, 15]. Science literacy is a method for engaging and motivating learners through the effective teaching of science by scientists. Science literacy is the ability to understand and use written language to build meaning from various science texts [16, 17]. PISA confirms that science literacy is very important in using scientific knowledge to answer questions and draw conclusions based on existing evidence, so one could understand and make a decision related to nature and changes to nature through the activities of man [18, 19]. Science literacy has attracted the attention of scientists, lecturers, and policymakers because it is very necessary in the modern society for tackling various problems in knowledge and technology [18, 20-22]. Science literacy is the ability to read, write, and communicate about science topics and socio-scientific issues, helping individuals to solve their day-to-day problems and promoting the creation of new knowledge in the field of science and technology [16, 17, 23]. The description gives a clear picture of science literacy for participants’ education.

Optimal ability science literacy will enable students to achieve impactful learning results. Learning results are all forms of outputs produced by the learning process, good knowledge, skills as well as attitude. The product of learning influences the students’ emotions greatly, specifically in the learning phase [24, 25]. Good learning outcomes are also influenced by the attitudes of a good student. The attitude of participants towards education could reflect from the character of students [26-28]. One mandatory attitude students must have is a social attitude. Social attitude is a trend for acting positively or negatively in special social situations [29, 30]. Characters of students will develop through experience and a continuous learning process. Good student characters are characterized by values and ethics like caring for others, honesty, fairness, responsibility, and respect for self and others [31-33]. The formed character could start with the interaction between fellows, exchanging information about circumstances, socializing, and interacting, in family, community, school as well as environment [30, 34]. Character is very important for participants’ education because the aim of education is to make participants know, care and internalize values so that they can behave as noble people. Good character increases the quality of education at school, and through the formation of good character, participants receive whole, comprehensive, and balanced education, according to standard [35-37].

However, at the moment, there are still many violent crimes occurring in different layers of society. There are various conflicts on the ground of ethnicity, religion, race, etc. in Indonesia. In the areas of character and science literacy in Indonesian, people are still weak and are unable to manage conflicts of ethnicity, religion, race, and inter-group so endless suspicion and hostility could easily occur [38, 39]. The minimum good character in an individual will help prevent social conflicts from happening [40, 41]. Weak character promotes mutual suspicion and conflicts in society [42, 43]. Through learning, participants should gain an understanding of the process of internalization and experience the practice of socializing, to increase awareness of national unity and individual values, social values, achievement of mental processes (knowledge and understanding) and acquire skills and abilities to socialize [44, 45]. Strengthening character results in the development of character to shape good citizens based on social values. This is what makes it important to emphasize character and science literacy.

One solution offered is a science learning model loaded with Balinese local wisdom. This learning model is loaded with Balinese local wisdom so that participants will be able to apply their learning based on their local context. Science learning packaged with local Balinese culture can develop basic science competencies [20, 46]. The existence of local wisdom-based learning can improve attitude and character [47, 48]. The application of a learning model containing Balinese local wisdom can fill the gap between scientific literacy and student character in the learning process [29] The application of local wisdom-based learning can also construct student behavior and character [48, 49]. Studying with a learning model that develops social-constructivist principles gives a big opportunity to live an easy life with the experience gained [50]. The science learning model will have collaborated with the Balinese local wisdom.

Local wisdom is a very decisive honor of entity and dignity of man in his community. Substantially, local wisdom is the value that applies in a society [51, 52]. Local wisdom is a local perception and ideas that contain wise, creative, kind values, which are internalized from generation to generation [53, 54]. The values of Balinese local wisdom contain the truth and thus are followed by the community member, and named the noble values (adhiluhung) which serve as the philosophy of good behavior basis towards harmonization [55, 56]. The Balinese local wisdom-based science learning model is defined as a series of learning activities contextualized based on real-life problems mixed with the problem-solving process that emphasizes the values themselves. By studying and analyzing in-depth aspects of Indonesian local cultural wisdom, especially in Bali, students can find many local wisdom concepts that have been practiced in people's daily lives. This learning model is an attempt at the role of education in developing 21st-century skills to master various skills [57, 58]. Based on the description, the science learning model loaded with Balinese local wisdom can impact science literacy and character.
Several supporting research statements, including research that states that science learning packed with Balinese local culture can develop competence-based science [59]. The existence of learning based on local wisdom is capable of improving skills, attitude, and character [47, 48, 60] Application of a learning model loaded with Balinese local wisdom can fill the gap between science literacy and the character of students in the learning process [29] Application of learning based on Balinese local wisdom can also improve behavior and character of students. Learning model based on problem-solving Balinese local wisdom is effective for increasing the ability to solve problems [61]. Based on descriptions, purposeful research is done to analyze the effectiveness of the science learning model -loaded with Balinese local wisdom in increasing the character and science literacy of students.

2. Materials and Methods

The present research is aimed at analyzing the effectiveness of learning based on Balinese local wisdom in improving character and scientific literacy in science learning. The study is a quasi-experimental design in the form of a posttest-only control design [62]. The implementation of this research was carried out by giving science learning treatment containing Balinese local wisdom for the experimental class and treating learning without a science learning model containing Balinese local wisdom. The second group or control group was given a post-test to know the difference between character and science literacy. The sample study uses a purposive sampling technique based on the location of schools in the area, city, suburb, town, and village with the characteristics of students with various diversity. The experimental group had 88 students and the control group had 70.

Questionnaires and tests were used as the data collection method for both character and critical thinking variable ability. Characters of participants evaluated are values that shaped moral feelings and moral actions (moral behavior ) in the form of attitudes, words, and actions participants manifest based on religious norms, laws, etiquette, culture, and customs as universal values of behavior participants exhibit [63]. Questionnaire character developed from character data obtained through a questionnaire following indicators that are (1) religious, (2) homes, (3) discipline, (4) democratic, (5) desire to know, (6) care, and (7) take responsibility [64]. The existing indicators will be developed into a 25-plain statement. A more complete character instrument grid is shown in Table 1.

Table 1.
Grid instrument character.

| No | Dimension   | Indicator                                                      | Statement Positive | Statement Negative | Amount |
|----|-------------|---------------------------------------------------------------|--------------------|--------------------|--------|
| 1  | Religious   | Happy pray                                                    | 1                  | 0                  | 1      |
|    |             | Always give thanks to God for enjoyment                      | 1                  | 0                  | 1      |
|    |             | Disclose admiration of God's greatness                        | 1                  | 0                  | 1      |
| 2  | Honest      | Say something right although that is bitter                    | 1                  | 0                  | 1      |
|    |             | Avoid cheating, plagiarism, or stealing                       | 0                  | 1                  | 1      |
|    |             | Have the courage for showing something right                   | 0                  | 1                  | 1      |
|    |             | Could be trusted to do something said                          | 1                  | 0                  | 1      |
| 3  | Discipline  | Obedient to the time set by the organization/school           | 1                  | 0                  | 1      |
|    |             | Obeying the applicable rules without feelings of being forced | 1                  | 0                  | 1      |
|    |             | Commitment and loyalty to assigned tasks/jobs.                | 0                  | 1                  | 1      |
| 4  | Democratic  | Think positive in every association with friends and colleagues | 1                  | 0                  | 1      |
|    |             | Show respect and appreciate every different opinion           | 0                  | 1                  | 1      |
|    |             | Listening to every view although different from personal perception | 1                | 0                  | 1      |
|    |             | Avoid pitched treatment harassing and demeaning other participating students, including those who are physically and mentally disabled | 1 | 1 | 1 |
| 5  | Sense of Want Know | Submit question                                  | 1                  | 0                  | 1      |
|    |             | Digging, tracing, and investigating                           | 0                  | 1                  | 1      |
|    |             | Interested in various things for which answers are not yet found | 1                | 0                  | 1      |
| 6  | Care        | Helping people in need                                        | 1                  | 0                  | 1      |
|    |             | To do social activities for helping people in need            | 0                  | 1                  | 1      |
|    |             | Maintain a clean school environment                           | 0                  | 1                  | 1      |
|    |             | Throw away trash in the trashbin                              | 0                  | 1                  | 1      |
|    |             | Turning off the water faucet that pours water not being used | 1                  | 0                  | 1      |
| 7  | Responsibility | Doing each job just to make a living                        | 1                  | 0                  | 1      |
|    |             | Doing Duty with good intention                                | 1                  | 0                  | 1      |
|    |             | Accept the risk of every action taken                        | 0                  | 1                  | 1      |

After the social attitude instrument was developed, then its validity and reliability were tested. Quantity score validity contents showed with Content Validity Ratio (CVR), CVR is in agreement with the recommendation of the experts (validators) of one item that can express level validity contents through indicator single range from -1 to 1. Conditions; If
CVR > 0, then item declared Valid. If CVR = 0, then the item is declared Invalid but Fixed. If CVR < 0, then item declared Invalid / Failed. Analysis result validation obtained an average score of 1 which means 25 questions were declared valid. The next reliability test is seen from quantity coefficient reliability Calculated Cronbach Alpha uses the SPSS Coefficient value correlation instrument obtained from Statistical Package for Social Sciences (SPSS) analysis. Standard instrument reliability follows Kerlinger's theory, that is, reliability of at least 0.70. the results of the validity and reliability test of social attitude instruments from 25 statement items obtained 2 2 valid statements and 3 failed items with a reliability value of 0.848 in the very high-reliability category.

Literacy data collection was done by testing science literacy, which includes 1) Scientific contexts, which refer to understanding concepts of science and applications in everyday life situations. 2) Scientific knowledge refers to an understanding of science content and science process. 3) Scientific competencies refer to the scientific process involved when answering questions or solving problems, such as identifying and interpreting proof as well as explaining the conclusion. The 3 existing indicators developed into 12 questions essay. A more complete, developed grid is described in Table 2. After the ability instrument of science literacy was developed, it was then tested for validity and reliability.

Table 2.
Grid Instrument literacy science.

| No | Dimension            | Indicator                                                                 | Question Item Number |
|----|----------------------|---------------------------------------------------------------------------|----------------------|
| 1  | Scientific contexts  | Explain in local situations the application of the concept of pressure based on the discourse presented | 1                    |
|    |                      | Determine and analyze the global situation of respiratory system disorders due to smoking based on the discourse presented | 3                    |
|    |                      | Personally, analyze the dangers of alcohol to human excretory organs based on the discourse given | 6                    |
|    |                      | gong musical instrument based on the given discourse | 8                    |
| 2  | Scientific knowledge | Evaluate and identify the concept of pressure in a problem | 2                    |
|    |                      | Construct, conclude, and identify the impact of smoking addictive substances | 4                    |
|    |                      | Construct and write about the process of decomposition of light in the formation of rainbows. | 10                   |
|    |                      | Comparing and critiquing rainbow formation based on the angle of incidence of the broadcast. | 11                   |
| 3  | Scientific Competencies | Identify, investigate data, and construct solutions for the dangers of smoking to respiratory health | 5                    |
|    |                      | Identify, investigate data, and construct solutions for the dangers of alcoholic beverages to human excretory health | 7                    |
|    |                      | Identifying problems and testing information from investigation results to solve sound wave problems | 9                    |
|    |                      | Comparing and critiquing the process of rainbow formation through scientific data investigation, especially the possibility of finding the end of the rainbow | 12                   |

The post-test data were analyzed using descriptive analysis and inferential statistical analysis. The Descriptive Analysis looked for mean value, standard deviation, and variance. inferential statistical analysis was used to know the influence of the science learning model containing Balinese local wisdom on improving character and scientific literacy. inferential statistical analysis was used with the Multivariate Analysis of Variance (MANOVA) test. Before the MANOVA test was implemented, formerly conditional tests were conducted, such as the normality test, homogeneity test, and multi-correlation test. The normality test data was intended to find out the population distribution data. The normality test of the data was carried out by using the Kolmogorov-Smirnov test and the Shapiro-Wilk test statistic. The criteria test is: the data is normally distributed if the resulting significance number is greater than 0.05. The homogeneity test is intended to show two or more sample data groups that have the same variance. Thus the differences that appear in the hypothesis testing come from the differences between groups. For this homogeneity test, the researcher used Levene's test of equality of error variance. The test criteria used were: the data have the same variance (homogeneous) if the resulting significance number is greater than 0.001 and in other cases, the sample variance is not homogeneous. MANOVA test was conducted with SPSS 26.0 for Windows help. The F test was conducted to test the hypothesis. It was conducted through multivariate analysis of variance (MANOVA). The multi-variata test would show each source of effect on the dependent variable, such as scientific literacy and student character. Multi-variata tests or tests between subjects were conducted on the F statistical value of significant figures of the Pillai's Trace, Wilks' Lambda, Hotelling, Trace, and Roy's Largest Root. A significance value less than 0.001 means that H0 is rejected, which means that there is an effect of the dependent variable between groups according to the source. All hypothesis testing resulted in a significance level of 5% because this research is a field of educational study.

3. Results and Discussions
3.1. Result
This study aimed at analysing the science learning model based on Balinese local wisdom effectiveness in improving the junior high school character and scientific literacy in Buleleng Regency. The research carried out got the results as expected, that the descriptive analysis resulted in the differences between students who were taught a science learning
model containing Balinese local wisdom and students who were taught without a science learning model containing Balinese local wisdom. The descriptive data analysis results are shown in Table 3. The results show that differences appear in the mean value, there is a difference in the average character value of the experimental class and control class of 0.279 and the difference in the average value of scientific literacy between the experimental class and the control class is 0.235.

| Table 3.  
The character and scientific literacy descriptive analysis results. |
| Treat | Dependent variable | Mean | Std. Deviation | Max. | Min. | N |
|--------|--------------------|------|----------------|------|------|---|
| Learning model science loaded with Balinese local wisdom | Character | 0.770 | 0.088 | 1.000 | 0.608 | 88 |
| No science learning model loaded with Balinese local wisdom | Science Literacy | 0.596 | 0.193 | 1.000 | 0.235 | 88 |

Analysis next conducted for post-test data is analysis MANOVA. Before conducting analysis MANOVA, result data analysis more formerly conditional tests were carried out that as normality test, homogeneity test, and multi-correlation test. The normality test was conducted using Kolmogorov-Smirnov. The analysis results show that all data come from groups of data that are normally distributed, and indicated by the value of Sig. > 0.05 which is 0.200. The results of a more complete analysis are shown in Table 4. After the normality requirements are met, the next prerequisite test is the homogeneity test. The homogeneity test in the study was conducted through two kinds of analysis, namely Levene's Test of Equality and Box's Test of Equality of Covariance Matrices. The results show the same meaning, namely, the research data comes from homogeneous data groups, this can be seen from the sig value, each test showed a value of more than 0.05. Value of Sig. Levene's Test of Equality is 0.119 for social attitudes, while the value of Sig. of critical thinking skills is 0.967. Meanwhile, in the Box's Test of Equality of Covariance Matrices test, the results of the variance matrix test on the data show the Box's M number of 4.606; the F value is 1.514, and the sig. of 0.209. The next prerequisite test is a multi-correlation test where this test aims to determine the relationship between each variable being analyzed. The results show that all tested data groups give a tolerance value > 0.1 and a VIF value <1,000 for each data group. In conclusion, the entire data group in this study did not have multicollinearity.

Table 4.  
Normality analysis results. |
| Treat | Kolmogorov-Smirnov |
|-------|--------------------|
| Character | Science Learning loaded with Balinese Local wisdom | 0.0018 | 88 | 0.200 |
|         | Without Science Learning loaded Balinese Local wisdom | 0.090 | 70 | 0.200 |
| Science Literacy | Learning Science loaded wisdom Balinese Local | 0.0018 | 88 | 0.200 |
|         | Without Learning Science loaded wisdom Balinese Local | 0.086 | 70 | 0.200 |

Table 5.  
Multivariate test results. |
| Effect | Value | F | Hypothesis df | Error df | Sig. |
|--------|------|---|---------------|----------|------|
| Intercept | Pillai's Trace | 0.984 | 4667.059 | 2.000 | 155.000 | 0.000 |
|         | Wilks' Lambda | 0.016 | 4667.059 | 2.000 | 155.000 | 0.000 |
|         | Hotelling's Trace | 60.220 | 4667.059 | 2.000 | 155.000 | 0.000 |
|         | Roy's Largest Root | 60.220 | 4667.059 | 2.000 | 155.000 | 0.000 |
| A | Pillai's Trace | 0.744 | 224.988 | 2.000 | 155.000 | 0.000 |
|    | Wilks' Lambda | 0.256 | 224.988 | 2.000 | 155.000 | 0.000 |
|    | Hotelling's Trace | 2.903 | 224.988 | 2.000 | 155.000 | 0.000 |
|    | Roy's Largest Root | 2.903 | 224.988 | 2.000 | 155.000 | 0.000 |

The test requirements for the MANOVA analysis have been met, where the research data are normally distributed, and homogeneous and there is no multi-correlation between variables so that hypothesis testing with MANOVA can be carried out. The complete analysis results are described in Tables 5 and 6. The result analysis shows that the F price for Pillae Trace, Wilk Lambda, Hotelling Trace, and Roy's Largest Root have more significance - small from 0.0 01, which means all significant. Therefore, it is declared that there is an influence of the science learning model containing Balinese local wisdom on character and science literacy. Tests of Between-Subjects Effects that relationship of learning model (A) with social attitude (Y1) gives the F value as 435.32 with a significance of 0.00 < 0.001. Therefore, the science learning model containing Balinese local wisdom has a positive influence on character. Meanwhile, the relationship between learning model (A) and science literacy (Y2) gives an F value of 57.5 0 with a significance of 0.00 < 0.001. Also, there is an influence of the science learning model containing Balinese local wisdom on science literacy. The results show that the science learning model that is based on Balinese local wisdom simultaneously promotes character and science literacy of
students. The next calculation is to determine the effectiveness of the science learning model containing Balinese local wisdom on the character and scientific literacy of junior high school students in Buleleng Regency, using the t-test shown in Table 7.

Table 6. Tests of between-subjects effects.

| Source       | Dependent Variables | Type III Sum of Squares | df | Mean Square | F     | Sig.     |
|--------------|---------------------|-------------------------|----|-------------|-------|----------|
| Corrected Model | Character value (Y1) | 3.038                   | 1  | 3.038       | 438.323 | 0.000    |
|              | Literacy value science (Y2) | 2.135               | 1  | 2.135       | 58.505  | 0.000    |
| Intercept    | Character value (Y1) | 61.972                  | 1  | 61.982      | 8879.251| 0.000    |
|              | Literacy value science (Y2) | 35.806              | 1  | 35.806      | 964.564 | 0.000    |
| A            | Character value (Y1) | 3.038                   | 1  | 3.038       | 435.323 | 0.000    |
|              | Literacy value science (Y2) | 2.135               | 1  | 2.135       | 56.505  | 0.000    |
| Error        | Character value (Y1) | 1.089                   | 156| 0.007       |        |          |
|              | Literacy value science (Y2) | 5.791              | 156| 0.037       |        |          |
| Total        | Character value (Y1) | 70.122                  | 158|             |        |          |
|              | Literacy value science (Y2) | 46.249              | 158|             |        |          |
| Corrected Total | Character value (Y1) | 4.127                   | 157|             |        |          |
|              | Literacy value science (Y2) | 7.926              | 157|             |        |          |

Table 7 shows that: (1) the value of t character is calculated from the root of F Manova F AY1 which is 20.86; the 2-way (2-tailed) significance value of 0.000 < 0.001 means that there is a significant difference in character between the experimental (A1) and control (A2) groups, where the mean Y1A1 is 0.770 > Y1A2 0.491 means that the science learning model containing Balinese local wisdom is more effective in improving the character compared to conventional learning models. This is reinforced by the ES value of 3.57 which is included in the high effectiveness category; (2) the t-value of critical thinking skills is calculated from the roots of F Manova FAY2 which is 7.58; 2-way (2-tailed) significance value of 0.000 < 0.001 means that there is a significant difference in scientific literacy (Y2) between the experimental (A1) and control (A2) groups, where the average Y2A1 is 0.596 > Y2A2 0.362, meaning that the science learning model contains Balinese local wisdom is more effective in improving scientific literacy compared to conventional learning models. This is reinforced by the ES value of 1.21 which is included in the high effectiveness category; (3) the simultaneous t-value is calculated from the root of F Wilks Lambda A, which is 15.00; 2-way significance (2-tailed) 0.000 < 0.001 means that there is a significant difference in character (Y1) and scientific literacy (Y2) between the experimental group (A1) and control (A2), where the mean Y1Y2A1 0.683 > Y1Y2A2 0.427 indicating that science learning model containing Balinese local wisdom is more effective in simultaneously improving the character and scientific literacy compared to conventional learning models. This is reinforced by the ES value of 1.89 which is included in the high effectiveness category.

4. Discussion
The results of the study reveal several findings. First, the science learning model containing Balinese local wisdom was effective in improving character. Its effectiveness cannot be separated from the activities and steps carried out in the learning process [65-67]. Science learning containing Balinese local wisdom familiarizes students with interacting with the surrounding environment because the learning process carried out is phenomenon-based. The problems that are taught are lessons found in everyday life. Phenomenon-based learning is built fundamentally on collaborative learning experiences and helps develop lifelong learning skills [50, 68] Phenomenon-based science learning motivates students to learn through the contextualization of real problems [20, 69]. This learning model also uses constructivist principles to encourage the application of prior knowledge, collaborative learning, and active engagement [70-72]. The science learning model containing Balinese local wisdom supports character strengthening because most of the syntax in this model is learned in groups. The formation of heterogeneous groups began right from the stage of the learning organization, then to the stage of developing and presenting the work of students collaborating in the learning process [73, 74]. Character strengthening is the result of character development forming good citizens based on social values [43, 75].

In addition, the content of Balinese local wisdom can form an attitude of tolerance, curiosity, responsibility, and care [11, 76, 77] Directly or indirectly, the character of students will be honed with an approach based on Balinese local wisdom because they are accustomed to collaborating with different backgrounds. Local wisdom can build and strengthen character [48, 78]. So, the character of students is formed as a result of the implementation of a structured learning model that
optimizes interaction in heterogeneous groups based on the content of Balinese local wisdom in the science learning model. The results of the study which stated the effect of science learning on students’ character compared to traditional teaching, found that science learning combined with local culture was effective in helping students acquire positive attitudes [79, 80]. Research states that learning based on phenomenon could integrate method planting classic, activity-based extracurricular in the form of activity religion, scouting, sports, and the Islamic arts, as well as habituation morals. This model has proven to increase morale [20, 81]. Research states that the implementation of PBL is an effective method in increasing the knowledge of students about the environment and developing a positive attitude toward the environment, Material most important from activity learning based on the problem is scenario prepared problem about eye lesson [10, 82, 83]. Research states the difference between the problem-based Trikaya Pari Sudha learning model on social attitudes and social studies learning outcomes [84]. Research states that the learning model Problem-Based Learning (PBL) based on local wisdom is stated positive effect on the social attitudes of students [85]. Thus, it can be said that the science learning model -loaded with Balinese local wisdom could effectively increase the character of students.

The second finding, the science learning model loaded with the Balinese local wisdom is effective in improving the science literacy of students. Science literacy has formed the existence habituation of students to study compatible problems with the application of a science learning model loaded with Balinese local wisdom. It is a pattern of communication and habituation of self-introspection for solving problems, analyzing the problem until you are capable of giving alternative solutions in state diverse groups are a very decisive step in science literacy. So the learning process of the rated student is more fun and challenging because could disclose his opinion with a good in-class variety [20, 86]. In learning based on wisdom, local science literacy is formed through heterogeneous groups so that the participants are trained to differentiate and decide which information is appropriate and which is not worthy of belief, which idea is supported by empirical evidence, and which idea is based only on assumptions [62, 87, 88]. So they are essentially built on collaborative learning experiences and help develop lifelong learning skills [50, 89]. Learning is based on phenomena using constructivist principles to encourage the application of prior knowledge, collaborative learning, and active engagement [70]. Science literacy needs to be possessed by students as a key strategy for learning science in the early years and should be applied in real life according to the situations faced by students in everyday life [90-92]. Based on this description, it can be said that the existence of learning containing Balinese local wisdom will provide opportunities for students to develop scientific literacy skills.

The third finding, based on the data results, the science learning model containing Balinese local wisdom simultaneously improves the character and scientific literacy of students. Meanwhile, multicultural learning that prioritizes local wisdom will foster children's awareness of the importance of respecting other people and different cultures [93]. When a science learning model containing local wisdom is applied, the achievement of scientific literacy will appear when completing assignments, both individually and in groups, with teacher assistance to provide new insights to students [94, 95]. The temporary character of the student is formed to interact with other people in the group in a way that shows respect to ideas and their behavior, by general application this help student learn skills and characteristics, such as collaboration and working for a team, thinking critically and solving problems, creativity and innovation, self-direction, and interpersonal relationship [96, 97]. Learning science-loaded wisdom Balinese locals can increase their character and science literacy.

The fourth finding, learning science-loaded wisdom Balinese local wisdom is more effective compared to learning without a science learning - model loaded with Balinese local wisdom Science learning - model loaded with Balinese local wisdom gives the opportunity participants to study more actively and solve their real-life problems more effectively [11, 98]. Active involvement of students in the learning process will make learning more meaningful which makes the student get experience that can be used in daily life [99, 100]. Learning science loaded with Balinese local wisdom helps the student to acquire science literacy with no answer accepted from other people. Science literacy is a method for engaging and motivating learners through effective learning of science and work scientifically [15, 17]. Scientific literacy is the ability to understand and use written forms of language needed by society in constructing meaning from various scientific texts [23, 101]. So the existence of this learning model will make students develop scientific literacy skills. In this learning process, there will also be a process of interaction between students both competing and working together which of course shapes the character of students. Students’ attitudes can be shown by behavior that can be seen by others and can be assessed for character [26, 27]. Learning science loaded with Balinese local wisdom is an activity-based learning that begins with the existence of real-life problems in the situation around the environment of the student with the splitting process of problem values character. Science learning model loaded with Balinese local wisdom is activity-based education in developing 21st-century skills for dominating the world [57]. Based on the description, a science learning model loaded with Balinese local wisdom could impact science literacy and the character of students. Therefore, this science literacy model is recommended to produce highly innovative graduates who are worthy in learning and character.

5. Conclusion

The science learning model loaded with Balinese local wisdom is effective in promoting students’ character and science literacy. Students use it to solve real-life problems.

References

[1] P. K. Malik, R. Singh, A. Gehlot, S. V. Akram, and P. K. Das, “Village 4.0: Digitalization of village with smart internet of things technologies,” Computers & Industrial Engineering, vol. 165, p. 107938, 2022. Available at: https://doi.org/10.1016/j.cie.2022.107938.
[2] S. Chabanet, H. B. El-Houzzi, and P. Thomas, "Coupling digital simulation and machine learning metamodel through an active learning approach in Industry 4.0 context," *Computers in Industry*, vol. 133, p. 103529, 2021. Available at: https://doi.org/10.1016/j.compind.2021.103529.

[3] M. I. Qureshi, N. Khan, H. Raza, A. Imran, and F. Ismail, "Digital technologies in education 4.0. Does it enhance the effectiveness of learning? A systematic literature review," *International Journal of Interactive Mobile Technologies*, vol. 15, pp. 31–47, 2021. Available at: https://doi.org/10.3991/ijim.v15i04.20291.

[4] J. Miranda, C. Navarrete, J. Noguez, J. Molina-Espinosa, M. Ramírez-Montoya, and S. Navarro-Tuch, "The core components of education 4.0 in higher education: Three case studies in engineering education," *Computers & Electrical Engineering*, vol. 93, p. 107278, 2021. Available at: https://doi.org/10.1016/j.compeleceng.2021.107278.

[5] H. Anggraeni, "Strengthening digital literacy-based blended learning in the face of the 4.0 industrial revolution era," *Al-Idara: Journal of Islamic Education*, vol. 9, pp. 190-203, 2019.

[6] L. Greenstein, *Assessing 21st century skills. A guide evaluating mastery and authentic learning*. USA: Corwin a Sage Company, 2012.

[7] A. Fatmawati, S. Zubaidah, and S. Mahanal, "Critical thinking, creative thinking, and learning achievement: How they are related," presented at the In Journal of Physics: Conference Series, IOP Publishing, 2019.

[8] D. Indraswati, D. A. Marthayani, D. Sutisna, A. Widodo, and M. A. Maulida, "Critical thinking and problem solving in social studies learning to answer the challenges of the 21st century," *Social Horizon: Journal of Social Education*, vol. 7, pp. 12-28, 2020. Available at: https://doi.org/10.31571/sosial.v7i1.1540.

[9] I. W. Redhana, "Develop 21st century skills in Chemistry learning," *Journal of Chemistry Education Innovation*, vol. 13, pp. 2239-2253, 2019.

[10] S. F. E. Rovers, G. Clarebout, G. Rovers, S. F. E. Clarebout, H. H. C. M. Savelberg, and V. Merriënboer, "Improving student expectations of learning in a problem-based environment," *Computers in Human Behavior*, vol. 87, pp. 416–423, 2018.

[11] R. A. K. Dewi and P. Rukmini, "The effect of thematic learning by using a scientific approach to increase the multiple intelligence of students," *Primary Education Journal*, vol. 7, pp. 40-46, 2019. Available at: https://doi.org/10.21831/ipe.v7i1.24326.

[12] T. Shepherd and M. Henderson, "Digital literacy in digital strategy," *Canadian Journal of Communication*, vol. 44, pp. PP51-PP56, 2019.

[13] O. Huseyn, M. Demirezen, and J. Pourfeiz, "Digital device ownership, computer literacy, and attitudes toward foreign and computer-assisted language learning," *Procedia-Social and Behavioral Sciences*, vol. 186, pp. 359-366, 2015. Available at: https://doi.org/10.1016/j.bspss.2015.04.028.

[14] A. Anggriani, S. Sarwi, and M. Masturi, "The effectiveness of guided discovery in distance learning to improve scientific literacy competencies of primary school students," *Journal of Primary Education*, vol. 9, pp. 454-462, 2020.

[15] H. Putranta, "Synthesis of the cognitive aspects’ science literacy and higher order thinking skills (HOTS) in chapter momentum and impulse," presented at the In Journal of Physics: Conference Series, IOP Publishing, 2019.

[16] A. Al Sultan, H. Henson Jr, and P. J. Fadde, "Pre-service elementary teachers’ scientific literacy and self-efficacy in teaching science," *IAFOR Journal of Education*, vol. 6, pp. 25–41, 2018. Available at: https://doi.org/10.22492/ije.6.1.02.

[17] T. E. Benjamin, B. Marks, M. K. Demetrikopoulos, J. Rose, E. Pollard, A. Thomas, and L. L. Muldrow, "Development and validation of scientific literacy scale for college preparedness in STEM with freshmen from diverse institutions," *International Journal of Science and Mathematics Education*, vol. 15, pp. 607-623, 2017. Available at: https://doi.org/10.1007/s10763-015-9710-x.

[18] N. Andriani, S. Saparini, and H. Akhsan, "Physical science literacy skills for class VII junior high school students in South Sumatra Using the PISA Framework (Program for International Student Assessment)," *Scientific Periodic Physics Education*, vol. 6, pp. 278-291, 2018.

[19] L. Lia, "Interactive multimedia as one of the learning alternatives in the field of science education," *Journal of Physics Innovation and Learning*, vol. 2, pp. 132-140, 2015.

[20] M. Nofiana and T. Juliano, "Efforts to improve students’ scientific literacy through local excellence-based learning," *Biosphère: Tadir Biology Journal*, vol. 9, pp. 24-35, 2018. Available at: https://doi.org/10.24042/biosf.v1i1.2876.

[21] T. Wibowo and A. Ariyatan, "Science literacy skills in high school students using ethnoscience-based chemistry learning," *Edusains*, vol. 12, pp. 214-222, 2020. Available at: https://doi.org/10.15408/es.v12i2.16382.

[22] O. C. Paramole, T. O. Bankole, and T. O. Okunoye, "Development and validation of teacher disposition scale among student-teachers in selected public tertiary institutions," *American Journal of Social Sciences and Humanities*, vol. 5, pp. 47-58, 2019. Available at: https://doi.org/10.20448/801.51.47.58.

[23] A. Fedorov and M. Galina, "Current trends in media and information literacy in research and scientific publications of the early 21st century," *International Journal of Media and Information Literacy*, vol. 5, pp. 153-163, 2020. Available at: https://doi.org/10.13187/jmil.2020.2.153.

[24] Y. S. Roh, K. I. Jang, and S. B. Issenberg, "Nursing students’ perceptions of simulation design features and learning outcomes: The mediating effect of psychological safety," *Collegian*, vol. 28, pp. 184-189, 2021. Available at: https://doi.org/10.1016/j.colegn.2020.06.007.

[25] D. D. C. Van Alten, C. Phielix, J. Janssen, and L. Kester, "Effects of flipping the classroom on learning outcomes and satisfaction: A meta-analysis," *Educational Research and Reviews*, vol. 28, pp. 1–18, 2019.

[26] C. B. Uomo, S. Siswati, and A. Munthohit, "Implementation of character education in shaping students’ attitudes and social behavior through history learning at SMA PGRI 1 Pati in the 2017/2018 academic year," *Indonesian Journal of History Education*, vol. 6, pp. 1-13, 2018.

[27] E. Surahman and M. Mukminan, "The role of social studies teachers as educators and teachers in improving social attitudes and social responsibility of junior high school students," *Harmoni Sosial: Jurnal Pendidikan IPS*, vol. 4, pp. 1-13, 2017. Available at: https://doi.org/10.21831/hspip.v4i1.8660.

[28] V. Dom, "I pursue higher education for reasons: Exploring the demand for higher education in Cambodia," *American Journal of Education and Learning*, vol. 4, pp. 314–324, 2019. Available at: https://doi.org/10.20448/804.4.2.314.324.
[29] S. Uge, A. Neolaka, and M. Yasin, "Development of social studies learning model based on local wisdom in improving students' knowledge and social attitude," International Journal of Instruction, vol. 12, pp. 375-388, 2019. Available at: https://doi.org/10.29333/iji.2019.12323a.

[30] Y. Bustami, A. D. Corebima, and E. Suarsini, "The social attitude empowerment of biology students: Implementation JiRQA learning strategy in different ethics," International Journal of Instruction, vol. 10, pp. 15-30, 2017. Available at: https://doi.org/10.12973/ji.2017.1032a.

[31] P. Asih and A. Sunarso, "Implementation of character education to improve the students discipline through habituation of Nadzam Asmaul Husna Recitation at Grade IV," Elementary School Teacher, vol. 3, pp. 1-4, 2020. Available at: https://doi.org/10.15294/est.v3i1.28035.

[32] I. Pertwi and S. Anwar, "Character education at Sekolah Alam Minangkabau and Sekolah Alam Ar-Royyan Padang," International Journal of Educational Dynamics, vol. 2, pp. 19-28, 2020. Available at: https://doi.org/10.24036/jieds.v2i2.267.

[33] M. A. Buchori, "Character education curriculum in the government of Indonesia strengthening character education program," JIEBAR: Journal of Islamic Education: Basic and Applied Research, vol. 1, pp. 137-153, 2020. Available at: https://doi.org/10.33853/jiebar.v1i1.101.

[34] A. C. Groenewoudt, G. Rooks, and P. J. van Gool, "When problems lead to ideas: The roles of daily vigor and social interactions," The Journal of Creative Behavior, vol. 53, pp. 286-297, 2019.

[35] J. D. Saputro and M. Murdiono, "Implementation of character education through a holistic approach to senior high school students," International Journal of Multicultural and Multireligious Understanding, vol. 7, pp. 460-470, 2020.

[36] S. Samsin and F. Fitriani, "Character-based learning and self-development to improve the students' character education," Educator Lantern Journal Science Tarb. and Teacher, vol. 23, pp. 108-126, 2020.

[37] F. I. P. Pratama, A. Kristiyanto, and W. Widiyastomo, "Character values of third grade slow learner in character education at the inclusive elementary school," Indonesian Journal of Education, vol. 10, pp. 345-352, 2021.

[38] A. Unwanullah, "Educational transformation to address community conflicts in a multicultural perspective," Journal of Educational Development: Foundations and Applications, vol. 1, pp. 1-13, 2012. Available at: https://doi.org/10.21831/jppfa.v1i1.1050.

[39] R. M. Fibriana, "Study on the development of the values of inter-religious harmony in a pluralistic society in Kalibago Village, Kediri Regency, East Java," Journal Educator Social Sciences, vol. 22, pp. 1-10, 2016. Available at: https://doi.org/10.17509/jits.v22i2.2191.

[40] R. S. Nagovitsyn, D. K. Bartosh, A. Y. Ratsimor, and Y. G. Maksimov, "Formation of social tolerance among future teachers," European Journal of Contemporary Education, vol. 7, pp. 754-763, 2018.

[41] N. A. Wiyani, "Implementation of a character education strategy in the perspective of permendikbud number 23 of 2015 at Raudhatul Afdhal," Tarbavisi: Scientific Journal of Educational Management, vol. 6, pp. 141-152, 2020.

[42] C. Schlein, R. J. Taft, and C. M. Ramsay, "The intersection of culture and behavior in social studies classrooms," International Journal of Social Science Studies, vol. 6, pp. 128–142, 2016.

[43] F. A. Agusti, A. Zafirah, E. Engkizar, F. Anwar, Z. Arifin, and S. Syafri, "The implementation of character values toward students through congkak game," Journal Researcher Educator, vol. 35, pp. 133–141, 2018.

[44] W. L. Smith and R. M. Crowley, "Social studies needs (new) white people: The case for including allies in the curriculum," The Social Studies, vol. 109, pp. 202-214, 2018. Available at: https://doi.org/10.1080/00377996.2018.1515720.

[45] R. Albas, "Study on the first appearance of social studies in the elementary school program in Turkey," International Education Studies, vol. 11, pp. 95-106, 2018.

[46] E. Winayarti, E. Handarsari, and A. Fathurohman, "Analysis of the development of the 'Local Tourism' learning model in science learning." Semin. Nas Has. Researcher, vol. 1, pp. 332–341, 2012.

[47] S. Budiwibowo, "Building character education for the younger generation through the culture of local wisdom in the global era," Premiere Educandum: Journal of Basic Education and Learning, vol. 3, pp. 39–49, 2016.

[48] P. Rachmadyanti, "Strengthening character education for elementary school students through local wisdom," Journal of Elementary School Education, vol. 3, pp. 201-214, 2017. Available at: https://doi.org/10.30870/jesd.v3i2.2140.

[49] L. H. Waite, M. A. Smith, and T. P. McGiness, "Impact of a problem-based learning elective on performance in non-problem-based learning required courses," Currents in Pharmacy Teaching and Learning, vol. 12, pp. 1470–1476, 2020.

[50] J. Bosica, J. S. Pyper, and S. MacGregor, "Incorporating problem based learning in a secondary school mathematics preservice teacher education course," Teaching and Teacher Education, vol. 102, p. 103335, 2021. Available at: https://doi.org/10.1016/j.tate.2021.103335.

[51] A. Mahardika, "Planting national character based on local wisdom in schools," Journal of Citizenship Education, vol. 7, pp. 16-27, 2017.

[52] R. Rukiyati and L. A. Purvastuti, "Model of character education based on local wisdom in elementary schools in Bantul, Yogyakarta," Journal of Character Education, vol. 7, pp. 130-142, 2016. Available at: https://doi.org/10.21831/jpk.v011.10743.

[53] K. Kasiyan and A. Sulistyo, "Integrating local culture-based character education in wood craft learning for mentally retarded students," Journal Educator Characters, vol. 2, pp. 217-232, 2020. Available at: https://doi.org/10.21831/jpk.v012.35032.

[54] J. B. Wastap, "The values of local knowledge form the nation's character in the Cirebon play, West Java," Mudra, vol. 32, p. 195194, 2017.

[55] N. K. R. Dewi, I. D. K. Tastra, and K. Pudjawan, "Development of learning videos based on local wisdom for balinese language subjects for class III students," Journal of Education Atuksha, vol. 5, pp. 12-22, 2016.

[56] I. G. Widnyana, I. W. Sujana, and I. K. A. Putra, "The influence of the Tri Hita Karana-based role playing learning model on the social sciences knowledge competence of fourth grade students of SD Gugus Untung Surapati, East Denpasar District, 2016/2017 academic year," PGSD Undiksha Pulpit, vol. 5, pp. 1-10, 2017.

[57] K. Beswick and S. Fraser, "Developing mathematics teachers’ 21st century competence for teaching in STEM contexts," ZDM, vol. 51, pp. 955-965, 2019.

[58] P. D. O. Widartirini, M. P. M. Putra, and I. B. S. Manuaba, "The effect of the Tri Hita Karana based group investigation learning model on science knowledge competence," Elementary School Scientific Journal, vol. 3, pp. 326-334, 2019.

[59] I. M. A. Winangun, "Media based on local culture in elementary science learning," Education: Journal of Basic Education, vol. 1, pp. 65-72, 2020.
Sudarmian, "Building children's character with local wisdom culture in the learning process at School," *EQUILIBRIUM: Journal of Economic and Education*, vol. 1, pp. 54-72, 2013. Available at: [http://doi.org/10.25273/equilibrium.v1i1.556](http://doi.org/10.25273/equilibrium.v1i1.556).

A. Pranjawini, N. N. Parwani, and G. Suwelen, "Local wisdom oriented problem solving learning model to improve problem solving ability and attitude toward mathematics students," *Journal of Mathematics Education Undiksha*, vol. 2, pp. 1-12, 2014.

A. Nisa, Sudarmin, and Samimi, "Effectiveness of using ethnosciences integrated modules in problem-based learning to improve students' scientific literacy," *Unnes Science Education Journal*, vol. 4, pp. 1049-1056, 2015.

R. Damanik and W. Sinaga, "The values of character in traditional games simulungun society," *Budapest International Research and Critics Institute (BIRCI-Journal): Humanities and Social Sciences*, vol. 4, pp. 1059-1069, 2021.

G. Barus, "Measuring the results of integrated character education in junior high school," *Education Horizon*, vol. 34, pp. 222-233, 2015. Available at: [https://doi.org/10.21831/cp.v2i2.4827](https://doi.org/10.21831/cp.v2i2.4827).

A. R. Subiyantari, S. Muslim, and E. Rahmadayanti, "Effectiveness of Jigsaw cooperative learning models in lessons of the basics of building construction on students' learning outcomes viewed from critical thinking skills," *International Journal for Educational and Vocational Studies*, vol. 1, pp. 691-696, 2019. Available at: [https://doi.org/10.29103/ijevs.v1i7.1653](https://doi.org/10.29103/ijevs.v1i7.1653).

F. M. A. Khan and M. Masood, "The effectiveness of an interactive multimedia courseware with cooperative mastery approach in enhancing higher order thinking skills in learning cellular respiration," *Procedia Social and Behavioral Sciences*, vol. 176, pp. 977-984, 2015.

J. Mari and S. A. Gunel, "Effects of jigsaw model of cooperative learning on self-efficacy and achievement in chemistry among concrete and formal reasoners in colleges of education in Nigeria," *International Journal of Information and Education Technology*, vol. 5, pp. 196-199, 2015.

B. Pratiwi, J. Copriyadi, and L. Anwar, "Implementation of phenomenon-based learning e-module to improve critical thinking skills in thermochromic material," *Jurnal Pendidikan Sains Indonesia*, vol. 9, pp. 575-585, 2021. Available at: [https://doi.org/10.24815/jpsi.v9i4.21114](https://doi.org/10.24815/jpsi.v9i4.21114).

L.-F. Lin, "The impact of problem-based learning on Chinese-speaking elementary school students' English vocabulary learning and use," *System*, vol. 55, pp. 30-42, 2015. Available at: [https://doi.org/10.1016/j.system.2015.08.004](https://doi.org/10.1016/j.system.2015.08.004).

Z. Zhou, "An empirical study on the influence of PBL teaching model on college students' critical thinking ability," *English Language Teaching*, vol. 11, pp. 15-20, 2018.

H. Hamdunah, A. Yunita, Z. Zaikardij, and M. Mahfazan, "Development a constructivist module and web on circle and sphere material with Wingeom software," *Journal on Mathematics Education*, vol. 7, pp. 109-116, 2016.

H. Cofré, C. González-Weil, C. Vergara, D. Santibáñez, G. Ahumada, M. Furman, M. E. Paredes, J. Camacho, R. Galgado, and R. Pérez, "Science teacher education in South America: The case of Argentina, Colombia and Chile," *Journal of Science Teacher Education*, vol. 26, pp. 45-63, 2015.

R. Rosnaeni, M. Muslimin, and S. Saehana, "Comparison of science process skills between groups of students taught with the POE (Predict-Observe-Explain) model and the discovery model in class X SMA Negeri 1 Sindu Tombusabora," *Journal of Physics Education*, vol. 6, pp. 43-53, 2018.

R. Rochmiatun, "Optimizing the application of the group discussion method to improve economic learning outcomes with the subject of economics and economic systems in class X.3 first semester students of SMA Negeri 3 Sukoharjo in the 2014/2015 academic year," *Journal of Education Social Sciences*, vol. 26, pp. 12-23, 2017.

A. Putra and V. R. Hasanah, "Traditional game to develop character values in nonformal educational institution," *IIAEDU-International E-Journal of Advances in Education*, vol. 4, pp. 86-92, 2018.

Ö. Polat and E. Aydin, "The effect of mind mapping on young children's critical thinking skills," *Thinking Skills and Creativity*, vol. 38, p. 100743, 2020.

S. Grossemann, M. Hojat, P. M. Duke, S. Menning, S. Rosenzweig, and D. Novack, ‘Empathy, self-reflection, and curriculum choice,’ *Interdisciplinary Journal of Problem-Based Learning*, vol. 8, p. 3, 2014.

I. Wijaya, ‘The local wisdom study of luan and teben concept on balinese ethnic houses (Case Study: Balinese Ethnic Houses in Denpasar, Bali),’ *Local Wisdom: Social Journal of Studies*, vol. 12, pp. 156-166, 2020.

M. Demirel and M. Dağyar, "Research article published online on Jul 02, 2016," *EURASIA Journal of Mathematics, Science and Technology Education*, vol. 12, pp. 2113-2137, 2016.

A. Khoir, Q. Agusuryani, and P. Hartini, "The growth of Islamic character through physics learning based on the integration of science-Islam," *Tadris: Journal of Teacher Training and Tarbiyah Science*, vol. 2, pp. 19-31, 2017.

Nurzaman, "The use of problem-based learning model to improve quality learning students morals," *Journal of Education and Practice*, vol. 8, pp. 234-248, 2017.

E. Ural and G. Dadli, "The effect of problem-based learning on 7th-grade students' environmental knowledge, attitudes, and reflective thinking skills in environmental education," *Journal of Education in Science Environment and Health*, vol. 6, pp. 177-192, 2020.

N. L. Andriyan and N. W. Suniasih, "Development of learning videos based on problem-solving characteristics of animals and their habitats contain in science subjects on 6th-grade," *Journal of Education Technology*, vol. 5, pp. 37-47, 2021.

I. G. S. S. Paske, I. K. Sudarma, and I. G. Astawan, "The effect of problem based Trikaya Parisudha learning model on social attitudes and social studies learning outcomes," *Indonesian Social Studies Education Journal*, vol. 3, pp. 1-9, 2019.

D. Soraya, I. N. Jampel, and K. S. Diputra, "The effect of the problem based learning (PBL) model based on local wisdom on social attitudes and critical thinking in mathematics subjects," *Journal of Education and Social Studies*, vol. 1, pp. 76-85, 2018.

A. Kardojo, M. Nurkhiin, and H. Pramusinto, "Problem-based learning strategy: Its impact on students' critical and creative thinking skills," *European Journal of Educational Research*, vol. 9, pp. 1141-1150, 2020.

M. D. Saputra, S. Joyoatmojo, D. K. Wardani, and K. B. Sangka, "Developing critical-thinking skills through the collaboration of jigsaw model with problem-based learning model," *International Journal of Instruction*, vol. 12, pp. 1077-1094, 2019.

R. Kumar and B. Refaei, "Problem-based learning pedagogy fosters students’ critical thinking about writing," *Interdisciplinary Journal of Problem-Based Learning*, vol. 11, pp. 5-10, 2017.

I. M. Zain, "The collaborative instructional design system (CIDS): Visualizing the 21st century learning," *Universal Journal of Educational Research*, vol. 5, pp. 2259-2266, 2017.
[90] A. Perusso and T. Baaken, “Assessing the authenticity of cases, internships and problem-based learning as managerial learning experiences: Concepts, methods and lessons for practice,” The International Journal of Management Education, vol. 18, p. 100425, 2020.

[91] Setiawan, D. K. Innatesari, W. B. Sabtiawan, and S. Sudarmin, “The development of local wisdom-based natural science module to improve science literacion of students,” Journal of Educator. Indonesian Science, vol. 6, pp. 49–54, 2017.

[92] S. A. Seibert, “Problem-based learning: A strategy to foster generation Z’s critical thinking and perseverance,” Teaching and Learning in Nursing, vol. 16, pp. 85-88, 2021. Available at: https://doi.org/10.1016/j.teln.2020.09.002.

[93] A. F. Noor and S. Sugito, “Multicultural education based in the local wisdom of Indonesia for elementary schools in the 21st century,” Journal of International Social Studies, vol. 9, pp. 94-106, 2019.

[94] K. L. Thorndahl and D. Stentoft, “Thinking critically about critical thinking and problem-based learning in higher education: A scoping review,” The Interdisciplinary Journal of Problem-Based Learning, vol. 14, pp. 1-21, 2020.

[95] M. Ülger, S. Yiğittir, and O. Ercan, “Secondary school teachers’ beliefs on character education competency,” Procedia-Social and Behavioral Sciences, vol. 131, pp. 442-449, 2014.

[96] B. T. Culclasure, K. C. Longest, and T. M. Terry, “Project-based learning (Pjbl) in three southeastern public schools: Academic, behavioral, and social-emotional outcomes,” Interdisciplinary Journal of Problem-Based Learning, vol. 13, p. 5, 2019.

[97] V. J. Skinner, A. Braunack-Mayer, and T. A. Winning, “The purpose and value for students of PBL groups for learning,” Interdisciplinary Journal of Problem-Based Learning, vol. 9, pp. 19–32, 2015.

[98] D. I. M. Aditya, “Development of illustrated children’s story books with the insertion of local Balinese culture on reading interest and attitudes of fifth grade elementary school students 2013 Curriculum,” Journal for Lesson and Learning Studies, vol. 2, pp. 53-63, 2019.

[99] K. J. Herrmann, “The impact of cooperative learning on student engagement: Results from an intervention,” Active Learning in Higher Education, vol. 14, pp. 175–187, 2013.

[100] J. Bartholomew, N. Golaszewski, E. Jowers, E. Korinek, G. Roberts, A. Fall, and S. Vaughn, “Active learning improves on-task behaviors in 4th grade children,” Preventive Medicine, vol. 111, pp. 49-54, 2018.

[101] A. Samsudin, J. B. Kelana, and A. Muftianti, “Utilization of internet-based learning media in enhancing science literacy capabilities of pgsd students,” PrimaryEdu: Journal of Primary Education, vol. 3, pp. 91-96, 2019.