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SSI-Integrated PjBL Model in Biodiversity Topics: Is it Effective for Increasing Students' Digital Literacy?

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Abstract: Educational institutions can utilize digital technology to engage students in various learning models. The presence of technology must be combined with 21st-century skills, including digital literacy. This research aims to determine the increase in digital literacy (communication and collaboration, critical thinking, ICT familiarity, data literacy, device security, dan personal security) of high school students in the application of project-based learning (PjBL) integrated with socio-scientific issues in biodiversity material. The method used in this research is the pre-experimental method with a one-group pre-test-post-test design. The population and sample are class X students from one of the high schools in Bandung City, consisting of 36 students. The instruments used consist of a questionnaire, observation sheets, and product assessment rubrics. The data obtained were analyzed using the paired sample t-test and the N-Gain analysis test with the help of the SPSS Ver program 25. The research results show an increase in students' digital literacy from the high category to the very high category with an N-Gain gain of 0.59 and being in the medium category. There has been an increase in digital literacy in each category, the highest increase was obtained by the ICT familiarity indicator (N-Gain=0.78) and the lowest was obtained by the personal security indicator (N-Gain=0.31). The digital literacy aspect of the digital handbook product created by students received an average score of 86.75% and was in the very high category.

Keywords: biodiversity topic, digital literacy, project-based learning, socioscientific issues

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INTRODUCTION

The current generation grew up with unlimited access to digital technology, and as a result, they have a different way of thinking than previous generations (Sinaga et al., 2023). Students rely more on gadgets or computers that can connect to the Internet to search for information from various sources (Elfarissyah et al., 2023). Education must prepare students to compete globally. The learning process needs to be related to the development of skills to face future challenges, namely 21st-century skills (Y. Anggraeni & Listiaji, 2024). The existence of 21st-century education will require schools or educational institutions to provide quick and responsive responses to current developments, one of which is by mastering information technology (Setyaningsih et al., 2019). Education in the 21st century ensures that students learn and can innovate, and use technology and information media (van Laar et al., 2017). One of the requirements for achieving 21st-century skills is literacy skills in students (Faridah et al., 2022).

World Economic Forum 2015 (in Iman, 2022) decided that there were several basic literacies including scientific literacy, reading and writing literacy, financial literacy, numeracy literacy, civic cultural literacy, and digital literacy. Digital literacy is important for students because they are familiar with technology, but they rarely use it for learning purposes (Waycott et al., 2010). Gurung & Rutledge (2014) state that digital students need guidance on how to use digital technology effectively for their learning needs and this is known as digital literacy.

A survey conducted by the Ministry of Communication and Information (Kominfo) shows that Indonesia's digital literacy in 2022 was in the medium category. Kominfo uses four pillars to measure digital literacy: digital, digital etiquette, digital culture, and digital security. The digital literacy index in the education segment in 2022 was 3.70. The pillar with the lowest score is the digital security pillar (Mega Aris Saputra et al., 2024). Based on these data, efforts still need to be made to increase students' digital literacy, especially for high school students.

The goals of 21st-century teaching are not easily achieved with conventional teaching, because in conventional teaching, the teacher plays the role of "knowledge transmitter" and students become "information recipients" (Alorda et al., 2011). This makes it difficult for students to play an active role in searching for information themselves. Therefore, there is a need for a teaching model that can support students to play an active role in developing their digital literacy (student-centered teaching).

One model of student-centered learning is project-based learning (Rotherham et al., 2010), hereinafter abbreviated as PjBL. Surur et al. (2023) reveal that PjBL can train digital literacy skills. The PjBL model is based on the concept of creative learning, which allows students to build their knowledge based on their experiences. PjBL can stimulate students to find sources of information independently through the stages of learning so that this can support their digital literacy skills (R. Anggraeni, 2019). The application of PjBL can provide challenges for students to solve problems in everyday life. They are also required to provide real action to solve these problems in the form of a work or product. Problem-solving activities in PjBL can use a socioscientific issue-problem approach.

Socioscientific issues are the issues that integrate scientific, cultural, and social in their content, and involve the application of knowledge and ethical reasoning in decision-making (Eastwood et al., 2012). The socio-scientific approach is implemented by analyzing phenomena, facts, or events based on social issues related to science that exist in society (Sismawarni et al., 2020). Learning using socioscientific issues involves knowledge and skills. The context of issues in socioscience must be chosen carefully by teachers to ensure that students have the background knowledge to engage in learning (Dawson & Venville, 2008). This means that teachers need to find material that contains socioscientific issues, one of which is biodiversity material.

Biodiversity material is important material because we often encounter examples of biodiversity in everyday life. The learning outcome for this material based on the Merdeka Curriculum is: "Students can create solutions to problems based on local, national, or global issues related to their understanding of the diversity of living things." Through this research, it is expected that there will be an increase in the digital literacy of high school students through the implementation of integrated project-based learning on socio-scientific issues in biodiversity material.

Based on the background, the research problem is how to increase students' digital literacy through the implementation of PjBL integrated with socio-scientific issues. Therefore, the research questions can be formulated as follows:

1. How does student digital literacy increase before and after implementing PjBL integrated with socioscientific issues?
2. How does student digital literacy increase in each indicator?
3. What is students' digital literacy in students' creative products?

METHOD

In this research, the pre-experimental method was used using a quantitative approach. (Sugiyono, 2010) reveals that the pre-experimental method is a design consisting of just one group or class, then given pre- and post-test treatment. This research uses a one-group pre-test-post-test research design. The population and sample in this study are grade X students of one of the state high schools in Bandung City. In this research, the sample was selected purposively, namely by considering certain aspects of the class that would be used as the research sample. Aspects considered in the sampling were students who had personal communication devices such as gadgets, had homogeneous cognitive abilities, were familiar with gadgets, and could use the Internet.

Before the teaching was carried out, the subjects were given a pre-test to measure their initial digital literacy abilities, then they were involved in integrated project-based learning on socio-scientific issues, namely on biodiversity material. At the end of the teaching and learning process, a post-test was given to measure students' digital literacy.

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In this research, quantitative data were used from non-test instruments. The instrument was a digital literacy questionnaire. The details of the research instruments used in this research are presented in Table 1 below.

Table 1. Research Instrument

Type of data	Type of Instrument	Tested Indicators	Test Type	Implementation
Digital literacy	Pre-test	Communication and Collaboration, Critical thinking, ICT familiarity, Data literacy, Device security, Personal Security	questionnaire	Beginning of teaching
	Post-test			End of teaching
Product evaluation	Non-test	Communication and Collaboration, Critical thinking, ICT familiarity, Data literacy, Device security, Personal Security	Assessment grid sheet (teacher/researcher)	End of teaching

Project-based learning integrated socio-scientific issues in this research refers to the syntax according to the Ministry of Education and Culture which consists of starting with the essential question, designing project activities (designing a plan for the project), creating an activity schedule (create a schedule), monitoring students and project progress (monitoring the students and progress of project), carrying out assessments (assessing the outcome), and reflecting on the experience gained (evaluating the experience). The socioscientific issue studied in this research is biodiversity which is almost extinct in Indonesia.

The digital literacy questionnaire consists of 27 statements based on digital literacy indicators by the G20 Toolkit for Measuring Digital Skills and Digital Literacy by (Wang et al., 2022). In this instrument uses Likert's five-point scale, but in this study, it was modified using a four-point scale, namely, strongly disagree (1), disagree (2), agree (3), and strongly agree (4). The modified questionnaire was then validated by measuring validity and reliability. The questionnaire was given at the beginning and end of learning. The details of the research instrument used in this research are presented in Table 2 below.

Table 2. Digital literacy questionnaire

No.	Element	Indicators	Description
1.	Complementarity	Communication and Collaboration	Ability to socialize using digital technology and skills in understanding digital communication means that suit your needs
		Critical thinking	Thinking critically about any information received on the Internet
2.	Familiarity	ICT familiarity	A person's fluency in using ICT devices (Wi-Fi network, browser, and downloading/installing applications)
		Data literacy	Ability to understand and explain the information needed, find and retrieve information/content/data digitally, and how to store and organize data and digital information
3.	Security	Device security	Ability to protect digital devices and content, and understand risks and threats in the digital environment
		Personal security	Ability to protect personal data and privacy

The scores obtained were calculated into grades with the following calculations:

$$\%\text{Questionnaire} = \frac{(\text{Frequencies obtained})}{(\text{Total frequencies})} \times 100$$

After the calculation of the percentage for each student's answer, the data were then presented based on the score interpretation criteria according to Arikunto Suharsimi (2013), namely very high, high, medium, low, and very low. These categories can be seen in Table 3.

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Table 3. Digital literacy percentage category

No.	Percentage (%)	Category
1.	0%-20%	Very Low
2.	21%-40%	Low
3.	41%-60%	Medium
4.	61%-80%	High
5.	81%-100%	Very High

After the digital literacy score was obtained, the pre-test and post-test scores were tested statistically using SPSS (Statistical Package for Service Solutions) software version 25.0. The testing included prerequisite tests and hypothesis tests to determine the average difference between the pre-test and post-test results.

The normality test used the Shapiro-Wilk test. The criterion for testing normality using Shapiro-Wilk was that if the significant value or probability value was less than 0.05, then the data were normally distributed (Sugiyono, 2010). The hypothesis test used was the difference between two means tests, aimed at seeing whether there was a significant difference between the pre-test and post-test averages of the group being tested. Data that were normally distributed were continued using the parametric paired sample t-test. For data originating from a population that was not normally distributed, the non-parametric Wilcoxon statistical test was used, with the following hypothesis.

H0 = There is no significant difference between the pre-test and post-test results of students' digital literacy abilities after the implementation of project-based learning integrated with socio-scientific issues.

H1 = There is a significant difference between the pre-test and post-test results of students' digital literacy abilities after the implementation of project-based learning integrated with socio-scientific issues.

If the hypothesis test results had a significant average difference between the pre-test and post-test, then the N-Gain test could be continued. Furthermore, the obtained N-Gain calculated values are grouped into three categories (Hake, 1999):

Table 4. N-gain value category

Score Range	Category
$g > 0.70$	High
$0.30 > g < 0.70$	Medium
$g < 0.30$	Low

Analysis of Student Digital Handbook

The resulting product is a digital handbook. Digital handbooks were assessed using a rubric created by researchers. The rubric contained digital literacy indicators to assess digital literacy in student products. The rubric used a score of 1-4 for each indicator. The assessment results data were calculated using the formula:

$$\%\text{Questionnaire} = \frac{\text{Gained frequency}}{\text{Total frequencyi}} \times 100$$

RESULTS AND DISCUSSION

Student Digital Literacy Increase

Before students were given treatment in the form of integrated project-based learning on socio-scientific issues, students took a digital literacy pre-test in the form of a questionnaire. After taking the pre-test, students were given integrated PjBL learning on socio-scientific issues in biodiversity material, then students were given a final test (post-test) to determine digital literacy after the treatment. The initial test and final test were carried out in the form of a Google form questionnaire offline in class. Student questionnaire answer scores were converted into percentages for easy reading. The data obtained

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were then analyzed using the average difference statistical test and N-Gain calculation. A recapitulation of statistical analysis and calculation of students' N-gain digital literacy is presented in Table 5.

Table 5. Recapitulation of Student Digital Literacy Analysis

Data Type		Pre-test (%)	Post-test (%)
N		36	36
Average		72.68%	88.88%
Standard Deviation		1.47%	2.69%
Minimum Value		69.44%	81.48%
Maximum Value		76.85%	94.44%
Shapiro-Wilk	Sig	0.122	0.177
Normality Test	Int.	Normal	Normal
Hypothesis Test:	Sig	0.000	
Paired sample t-test	Int.	Significantly different	
N-Gain	Average	0.5938	
Calculation	Int.	Medium	

Later, a hypothesis test was carried out, because the pretest and posttest data were normally distributed (p-value (pre: 0.122 and post: 0.177) > α 0.05) so the test was continued with a parametric test, in this case, the paired sample t-test. Based on Table 4.3, it is known that the paired sample t-test results show sig. equal to 0.000 or < α 0.05, based on the results of the hypothesis test, H0 is rejected and H1 is accepted. It can be concluded that there is a difference in the average digital literacy of students before and after the implementation of PjBL-integrated socio-scientific issues in biodiversity material.

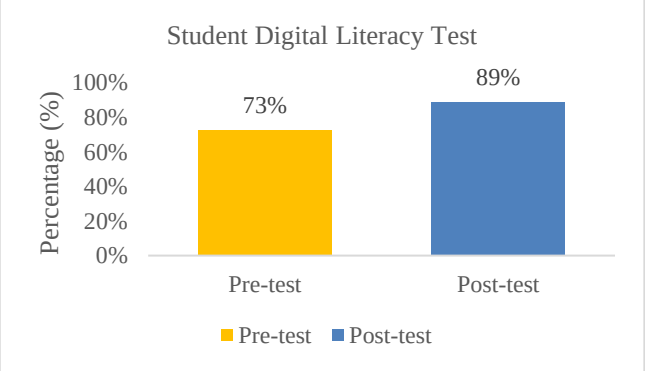

Figure 1. Percentage average of student digital literacy at pre-test and post-test

Based on Figure 1, before the implementation of SSI-integrated project-based learning on biodiversity material (pre-test), the percentage of students' digital literacy reached 73% (High), while the post-test score showed that the average percentage of students' digital literacy reached 89% (Very High). The mean difference is in line with the hypothesis test using the paired sample t-test which shows that there is a difference between the pre-test and post-test.

Apart from calculating the difference in the average percentage of pre-test and post-test, this research looked at the distribution of students' digital literacy percentage categories in the pre-test and post-test. The digital literacy category is interpreted based on Arikunto Suharsimi (2013). The digital literacy category contains very low, low, medium, high, and very high. The student percentage results can be seen in attachment B.2 Medium students' N-Gain values, which can be seen in attachment C.3. Figure 4.8 is a distribution table for students' digital literacy categories

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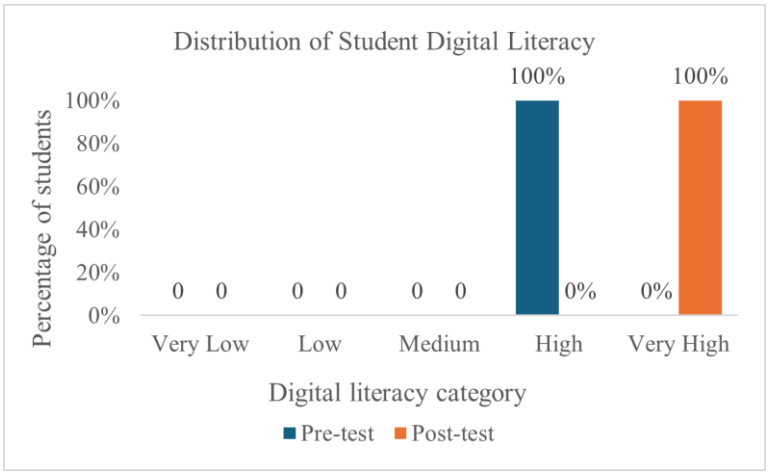

Figure 2. Distribution of student digital literacy percentage category before and after treatment

Based on Figure 2, all students' digital literacy pre-test scores were in a high category, which then rose to the very high category in the post-test results. The data reveal that students' digital literacy increased after they were given treatment in the form of integrated project-based learning on socio-scientific issues in biodiversity material. The results of this increase are supported by research by Surur et al. (2023) which reveals that project-based learning is learning that is suitable for increasing digital literacy because project-based learning prioritizes constructivist learning which involves the use of classic and digital books as well as field activities. The results of research by Sinaga et al. (2023) show that the use of PjBL enables students to communicate with digital literacy content from structures related to their experiences and be more proactive in providing ideas. So that students can be involved independently in providing discussions and discussing important content, a learning environment for the topic of socioscientific issues can be applied (Eastwood et al., 2012).

Increasing students' digital literacy can also be affected by the good facilities students have, which can be used to search for information, digital data literacy, digital devices, and other digital activities. The progress of digital skills possessed by students is also supported by statements from Hoechsmann and Poyntz (2012; 24) (in, Sahidillah & Miftahurrisqi, 2019) who argue that with so many media choices today, it is not surprising that teenagers or students become someone who can master various media, because they can spend more time on social media compared to teenagers or students in the past. Kusuma (2011) (in, Sahidillah & Miftahurrisqi, 2019) believes that young people (in this case students) are more familiar with new media/digital media than parents and teachers. It can be concluded that one of the factors in students' high digital literacy abilities is because they have mastered information and digital media, and then this happened in this research.

Table 5 shows the results of the N-gain calculation which shows a score of 0.59 so based on the criteria developed by Hake (1999) this score is included in the medium category. Furthermore, the distribution of N-Gain value categories can be seen in Figure 3.

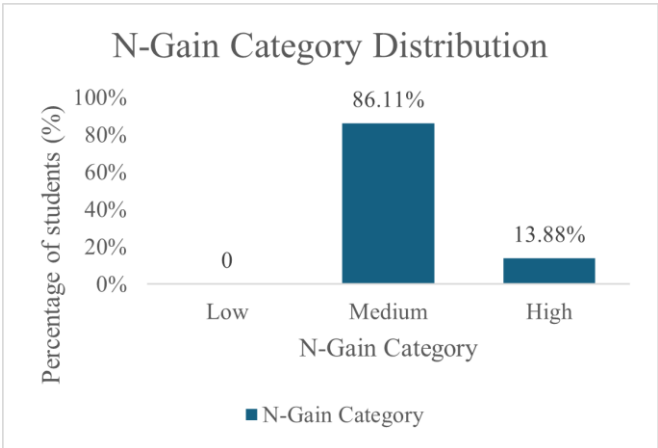

Figure 3. Category of N-gain value interpretation

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Each student's N-gain score is dominated by the medium category (86.11%). This means that increasing digital literacy from integrated project-based learning on socio-scientific issues in biodiversity material as a whole is in the medium category. In this category, students are quite good at digital literacy. This shows that the application of project-based learning integrated with socio-scientific issues in biodiversity material is quite effective in increasing students' digital literacy. The results of research by Sinaga et al. (2023) show that the PjBL model is effective in improving students' numerical literacy and digital literacy. Students also agree that the process in PjBL can help them improve their numeracy and digital literacy skills. Faridah et al. (2022) state that project-based learning has proven effective in increasing students' digital literacy.

Integrating socioscientific issues into project-based learning can stimulate students to solve local and global issues by utilizing digital technology. Students can search for information with a wider and global reach through digital literacy, students can also learn to use digital access effectively and safely. According to Elfarissyah et al. (2023), PjBL is expected to make it easier for students to understand the learning context and create an optimal learning experience for them so that they can develop their digital literacy in the learning process. The results of research by Elfarissyah et al. (2023) showed that as many as 29.2% of students said that learning to read using technology could make it easier for them to get quite good reading material, and 20.8% of the students said the reading material they got was good, and as many as 50% of students stated that the reading materials used were very good. These results show that learning using technology can make it easier for students to obtain reading materials. From the results of the average score of the pre-test, post-test, Wilcoxon test, and N-Gain calculations that have been carried out, it can be seen that the implementation of integrated project-based learning on socio-scientific issues in biodiversity material is quite effective in equipping students with digital literacy skills.

The Increase of Student Digital Literacy on Each Indicator

The measurement of each indicator aims to determine students' digital literacy indicators for each indicator before and after the integration of project-based learning into socio-scientific issues in biodiversity material and to find out which indicators are good and which need to be improved. The percentages of pre-test and post-test scores on each digital Literacy indicator along with the N-gain score and its interpretation can be seen in Table 6.

Table 6. Average pre-test and post-test percentages on each digital literacy indicator

Component	Average Score					Int.
	Pre-test	Int.	Post-test	Int.	N-gain	
Communication and collaboration	72.74	High	90.28	Very High	0.64	Medium
Critical thinking	69.97	High	84.72	Very High	0.49	Medium
ICT familiarity	74.07	High	94.44	Very High	0.78	High
Data literacy	74.44	High	93.75	Very High	0.75	High
Device security	70.63	High	83.04	Very High	0.42	Medium
Personal security	75.69	High	91.67	Very High	0.65	Medium

Table 4.3. shows the average percentage of each indicator increases from pre-test to post-test. This increase in the average percentage of digital literacy occurred due to the implementation of learning using integrated PjBL socioscientific issues in biodiversity material. Socioscientific issues use scientific science issues aiming at making the topic interesting and personally meaningful for students, and social science topics must use evidence-based thinking and provide a context for understanding scientific information (Zeidler et al., 2008). The advantages of project-based learning are that it can increase students' motivation in preparing projects, improve problem-solving abilities, increase collaboration and cohesiveness abilities, and improve resource management skills (Niswara et al., 2019). The generation that grew up with unlimited access to digital technology will have a different mindset compared to previous generations (Faridah et al., 2022). The same thing happened in this research, where students were taught using SSI-integrated project-based learning which could facilitate improving each digital literacy indicator. To see the increase in digital literacy from the pretest to the posttest for each indicator, a graph of the N-Gain score for each indicator was created as shown in Figure 4 below.

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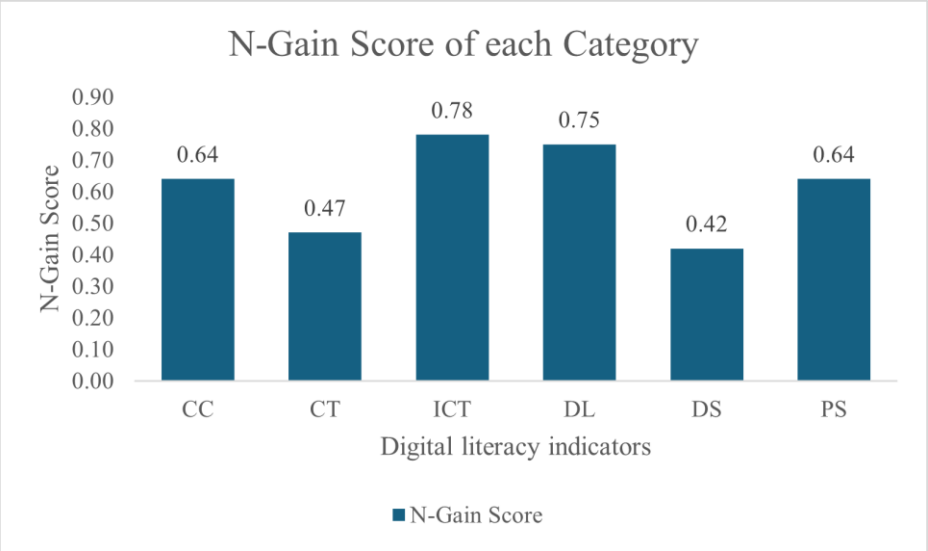

Figure 4. N-Gain score of each digital literacy Category

Notes:
CC : Communication and Collaboration
CT : Critical thinking
ICT : ICT familiarity
DL : Data literacy
DS : Device Security
PS : Personal Security

Based on Figure 4, the six digital literacy indicators consisting of communication and collaboration, critical thinking, ICT familiarity, data literacy, device security, and personal security have increased to the medium category, while the ICT familiarity indicator is in the high category. The highest N-Gain score was obtained by the ICT familiarity indicator, namely 0.78 (high category). The indicator with the lowest N-Gain score was obtained by the device security indicator, which was 0.42 (medium category).

ICT familiarity obtained the highest N-Gain score because the average percentage of post-test and increase from pre-test to post-test on this indicator was higher than that on other indicators (Table 5). The aspect measured in the ICT familiarity indicator is how comfortable and accustomed a person is in operating ICT devices such as Wi-Fi networks, downloading and installing applications, and operating browsers (Wang et al., 2022). In this research, there are three statements taken from the G20 Toolkit for measuring digital skills and digital literacy by Wang et al. (2022) to measure indicators of ICT familiarity. The statements include the ability to connect to a Wi-Fi network, cellular network, or Bluetooth; download and install applications; and how to operate the browser.

This increase in ICT familiarity indicators can occur because of the implementation of project-based learning which is integrated with socio-scientific issues and can train students to get used to using information and communication technology to produce a creative product, namely a digital handbook. This is supported by the statement by Sefriani et al. (2021) that the implementation of learning using applications or learning platforms can make students more proficient in using digital devices and help students care more about technology so that they can improve their digital literacy skills. Several main factors that can affect the use of technology for learning are students' computer technology skills, attitudes toward the technology, learning styles, and the support of friends and teachers (Lee et al., 2016). By creating a digital handbook, students can practice their abilities in using information technology, using various editing applications both online and offline, searching for information sources via a browser, and connecting to the Internet.

Project-based learning encourages students to share their feedback and knowledge with peers in a collaborative group, and then they will use modern e-learning technology to share their findings (Eliana et al., 2016). Therefore, PjBL using ICT needs to be introduced in the classroom to support students in creating their knowledge (Soparat et al., 2014). This happened in this research, where during learning by implementing integrated PjBL socioscientific issues in this research students actively used

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the Internet, various applications, and search engines (Google, Safari, etc.) to facilitate students to be trained in using communication and information technology (ICT).

Meanwhile, the device security indicator obtained an N-Gain score of 0.42 and the average post-test percentage of 83.04%, which were low compared to other indicators. The calculation results can be seen in Table 4. This indicator measures the ability to protect digital devices and content and understand risks and threats in the digital environment (Wang et al., 2022). In using digital platforms, the ability to manage and protect devices is needed because devices are the main channel for personal security (Wang et al., 2022). The percentage of pre-test to post-test on the device security indicator increased from 70.63% (high category) to 83.04% (very high category). However, for the N-Gain score, the device security indicator has a score that is lower than the other indicators, namely 0.42, and is included in the medium category.

Based on the results of students' digital literacy questionnaire answers on device security indicators, students feel capable of determining the correct password and they are also familiar with the threat of viruses on devices, two-step account verification, and backing up data. However, some students still incorrectly determine the correct password combination for the account. The results of the research on the device security indicator are similar to the results of research conducted by Mariyani & Triyani (2023), in which the average score for students' digital literacy abilities was the smallest in the electronic security indicator, with a score of 2.24 (low category).

Apart from that, the low increase in the device security indicator can be caused by students' lack of awareness of device security, students only focus on using the Internet itself without considering the risks of digital world threats that may occur. Even though the use of social media has been going on for years, it does not have a significant effect on their literacy awareness behavior regarding security and privacy threats in using social media (Revilia & Irwansyah, 2020). In terms of security settings, the results show that individuals are aware of their password settings as reflected in their intention to pay more attention to creating complex passwords to behave safely when using social media (Revilia & Irwansyah, 2020). The results of digital literacy measurements by the Ministry of Communication and Information show that the digital literacy index in Indonesia is based on four indicators (digital skills, digital ethics, digital safety, and digital culture), and of these four indicators, the lowest index is the digital safety indicator, namely 3.12. The survey results show that understanding of digital security in Indonesia is still relatively low. A low understanding of digital security also occurred in this research.

Student Digital Literacy on Student Creativity Product

Project-based learning is synonymous with the product produced. Apart from being measured using questionnaires, in integrated PjBL learning socioscientific issues, students' digital literacy can be measured from the products produced by students. In this research, the product produced is a digital handbook. Each group created a digital handbook on the theme of biodiversity in Indonesia which is almost extinct. The species of living creatures for each group is determined by the group itself with the condition that it must be different from other groups. The list of species chosen by students to be discussed in the digital handbook for each group is presented in Table 7 below.

Table 7. List of species used in each group

Group 1	Flora	Fauna
1	*Dermochelys coriacea, Macrocephalon maleo,*	*Grammatophyllum speciosum, Aquilaria malaccensis*
2	*Leucopsar rothschildi, Macaca nigra*	*Coelogyne pandurata, Taxus sumatera*
3	*Pavo cristatus, Panthera tigris sumatrae*	*Rafflesia arnoldi, Amorphophallus titanum*
4	*Dicerorhinus sumatrensis, Dendrolagus mbaiso*	*Grammatophyllum speciosum, Anaphalis javanica*
5	*Elephas maximus sumatranus, Pardofelis badia*	*Santalum album, Magnolia champaca*
6	*Nisaetus floris, Bubalus depressicornis*	*Nepenthes bicalcarata, Dendrobium phalaenopsis*

Products are assessed using a product assessment rubric which contains digital literacy indicators. This indicator is related to the variable measured in this research, namely digital literacy.

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Based on the product assessment, a recapitulation of the assessment is obtained and presented in Table 8 below.

Table 8. Recapitulation of the results of the student digital handbook assessment by the teacher for each group

Aspect	Indicators	Result of Each Group Evaluation						Averag
		1	**2**	**3**	**4**	**5**	**6**	e
Digital literacy	*Communication and collaboration*	3.67	3.33	3.00	3.33	3.33	4.00	3.44
	Critical thinking	3.00	2.67	2.00	3.33	3.67	3.67	3.05
	ICT familiarity	4.00	3.50	3.00	3.50	4.00	4.00	3.66
	Data literacy	4.00	4.00	4.00	4.00	4.00	4.00	4
	Device security	4.00	4.00	4.00	4.00	4.00	4.00	4
	Personal security	4.00	3.00	4.00	3.00	3.00	3.00	3.33
Total		**22.67**	**20.5**	**20**	**21,16**	**22**	**22,67**	**21.5**
Total average score		**3.64**	**3.27**	**3.00**	**3.45**	**3.64**	**3.82**	**3.47**
Percentage (%)		**91**	**81.75**	**75**	**86.25**	**91**	**95.5**	**86.75**
Category		**Very High**	**Very High**	**High**	**Very High**	**Very High**	**Very High**	**Very High**

Table 8 shows that each group has different assessment results. The digital literacy indicator for Groups 1, 2, 4, 5, and 6 products is in the very high category, while the digital literacy indicator for Group 3 products is in the high category. Based on the teacher's assessment, Group 6 has the highest average percentage, namely 95.5%, and is in the very high category. Group 3 got the lowest percentage among the other groups, namely 75%, which is in the high category. This shows that students' digital literacy varies. The difference in product results is due to collaboration in small groups (Hadi et al., 2019). This is in line with Hadi et al. (2019) who reveals that project-based learning will open up opportunities for students to convey ideas, listen to other people's ideas, and reflect their ideas to others. This assessment is carried out to see indicators of digital literacy in the digital handbook that students have created. So that the digital literacy indicators on the product pictures are clearer. The average digital literacy scores for each indicator are presented in Figure 5.

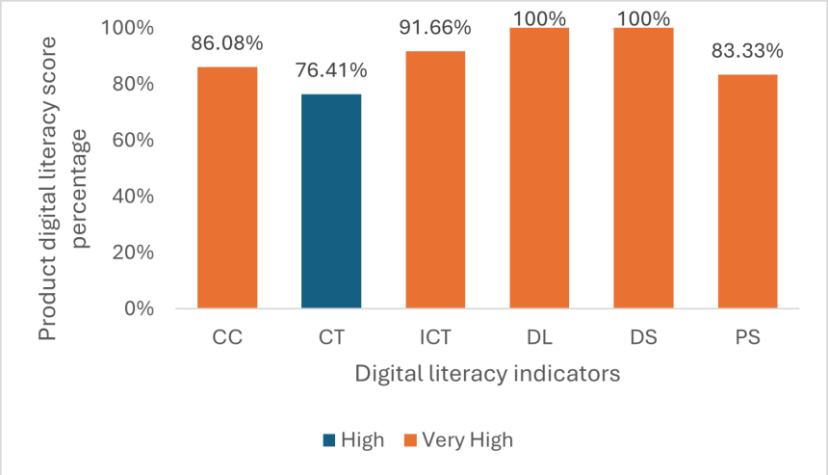

Figure 5. Average digital literacy score for each product indicator

Notes:
CC : Communication and sollaboration
CT : Critical thinking
ICT : ICT familiarity
DL : Data literacy
DS : Device security
PS : Personal security

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Overall, the digital literacy indicators for products are in a good category. Like the digital literacy indicators explained in the previous section, the indicators in this section also have the same representation as the digital literacy indicators.

Student communication and collaboration indicators have been facilitated because during the creation of the digital handbook students used digital devices to work in groups, and apart from that, monitoring and feedback from teachers were also carried out using digital communication tools, namely via email and WhatsApp. In line with the statement of the (Wang et al., 2022), communication and collaboration include the ability to interact through various digital technologies and understand digital communication tools that are appropriate to a particular context for using these technologies. One effort to increase digital literacy is to increase the ability to collaborate with other people to create knowledge and meaning together (Mariyani & Triyani, 2023).

Students use digital technology and applications including gadgets, laptops, Canva, Google Docs, and Google Drive, so that in practice they are familiar with or accustomed to using ICT devices, which means that the ICT familiarity indicator has been facilitated. (Sefriani et al., 2021) reveal that teaching using applications or learning platforms can make students more proficient in using digital devices and help them care more about technology so that they can improve their digital literacy skills.

Students have included four main contents in their digital handbook, namely taxonomy and regional origin, extinction status, causes of extinction, and role in ecology. This shows that students have carried out data literacy on digital information sources to obtain this content. This is in line with the statement by Rais et al. (2020) that projects carried out in PjBL become a medium for students to carry out exploration, interpretation, synthesis, and information in producing various forms of learning outcomes.

In the reference sources, students have also stated that the references they use come from safe and legal sources. This shows that students have paid attention to the security of their devices during the learning process. During the online monitoring process, students send a Canva link via email and WhatsApp. In practice, students can control who is allowed to edit, comment, and view the progress of their digital handbook via this link. This is done to minimize unintentional data loss or errors such as parts deleted by someone else. In this way, personal security indicators have been well facilitated. In line with the digital literacy survey in Indonesia (2020), where the highest score was in the technology and security capability sub-index, electronic security involves developing an understanding of the appropriate use of digital technology (Mariyani & Triyani, 2023).

Meanwhile, indicators in the high category are critical thinking indicators. The critical thinking indicator is the indicator with the lowest score among the other indicators. This indicator has not been implemented optimally, including being influenced by students' lack of ability to find relevant sources and their paraphrasing abilities which are still not good. The existence of less relevant sources and sentences that have not been paraphrased well indicates that students are still not able to analyze and interpret the information very well. In line with the statement in the G20 Toolkit book (Wang et al., 2022), critical thinking skills refer to the ability to analyze, compare, and evaluate sources of data, information, and digital content critically and reliably. Even though the critical thinking indicator has a low score compared to other indicators, overall this indicator has been well facilitated and received the high category. One example of a handbook product produced by students can be seen in Figure 6.

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Figure 6. Example of a digital handbook made by students

CONCLUSION

Several conclusions have been drawn based on the findings of research on the effect of implementing integrated project-based learning on socio-scientific issues on biodiversity material.

There was an increase in students' digital literacy before and after the implementation of integrated project-based learning on socio-scientific issues in biodiversity material. The increase was marked by the results of the pre-test digital literacy questionnaire which was in the high category, experiencing an increase in the post-test results which reached the very high category. Students' digital literacy experienced a significant increase and obtained an N-Gain score of 0.59 which is in the medium category. It can be concluded that the increase in students' digital literacy in learning using the PjBL model which is integrated by SSI in biodiversity material is in the medium category.

The highest average percentage and N-Gain value were obtained from the ICT familiarity indicator with the very high category for the percentage and the high category for the N-Gain value (N-Gain=0.78, Percentage=94.44%). The average and low N-Gain values were obtained for device security indicators with the very high category for the percentage and the medium category for the N-Gain value (N-Gain=0.42, Percentage=83.04%).

Digital literacy in creative products in the form of digital handbooks received a very high category. Of the six groups, five groups were in the very high category and one group was in the high category. The personal security and device security indicators obtained the highest percentage (100%) in the very high category. Then the low percentage is in the critical thinking indicator (76.41%) in the high category.

In the future, the application of integrated project-based learning on socio-scientific issues can be tried on other materials as long as they have material characteristics related to socio-scientific issues. The implementation of SSI's integrated PjBL can be used to see skills or other abilities that can support 21st-century skills. This learning can be applied flexibly and combined using blended learning, namely a combination of offline and online learning.

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