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Development of IBSC (Investigation Based Science Collaborative) Based Student Worksheet on Human Respiratory System to Improve Science Literacy and Collaboration Skills of Grade XI Students

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Abstract: In the 21st century, students need to have scientific literacy abilities and collaborative skills in order to be able to compete in this era. This study aims to knowing the validity, the practicality and to determine the effectiveness of IBSC (Investigation Based Science Collaborative) based student worksheet used as teaching materials on human respiratory system to improve student's science literacy skills and collaboration skills. This development research was conducted using the ADDIE model and the data analysis used was the Manova test. The results of the study are the student worksheet is declared valid for use in the process of learning activities with an average validation score in the good category. Its also received a score in the very good category in terms of readability and practicality. The Manova test results showed a Sig. 0.000 with N-Gain values are 60.57 and 62,58 in fairly effective catefory which means there is a significant difference in the science literacy skills and collaboration skills of students who using and not using IBSC (Investigation Based Science Collaborative) based student worksheet.

Keywords: Collaborative Skills; Investigation Based Science Collaborative; Science literacy

Introduction

The 21st century, the century starting from 2001 to 2100, is known as the era of globalization which uses the internet as a medium for spreading news or information. The use of the internet in this era of globalization is also increasingly widespread in various fields, one of which is the field of education. Kristiyanti (2010) argues that a person can access various references, both in the form of research results, as well as articles from studies in various fields. One also no longer has to physically go to the library but only needs to sit in front of the computer and connect it to the internet. The information available and accessible through the internet is also not only available or happening in one country, but also in all corners of the world.

Pena Belajar Kemendikbud explain that in the 21st century learning has changed from learning by verbalism to applying skills. The principle of learning in the 21st century has been focused on the student, so learning resources are no longer teacher-oriented and more towards scientific approaches and learning that's initially content-based into competence-based learning. (Zubaidah, 2016). However, it cannot be denied that the role of the teacher remains necessary in learning. But, the involvement of the teacher's role must be limited. Student worksheet is a sheet that contains the tasks that must be done by the students and is one of the means to

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help and facilitate learning activities so that it will form an effective interaction between students and teacher. Besides, it can improve the activity of students in improving learning outcomes. Student worksheet can be a learning resource for students who can provide experience and skills in the learning process, as well as to build the attitude or character of the students (Kaleka & Nur, 2018). It can be a guidelines for training development of cognitive aspects also the development of all aspects of learning in the form of experiments or demonstration guideline (Pratita et al., 2018).

Based on this explanation, it is known that in the era of globalization where learning is more student-centered, teaching materials are needed that can help them to be able to understand the lessons more deeply, not just the concept. Especially in biology subjects where biology is a lesson that is considered complicated and can only be learned through memorization. Students only memorize facts, principles, and theories that are taught by the teacher without trying to find out, develop, or apply the concepts they have thought. Meanwhile, science learning is very important because science is a means of clear and logical thinking, a means to solve problems of everyday life, to develop creativity and to raise awareness of cultural developments (Hartono et al., 2022). Thats why, learning science sometimes feels weighty and dull, which prevents students from understanding what they are learning in the end. Students' souls have not been truly touched by the knowledge and application of scientific literacy abilities that rely solely on textbooks or texts. The lecture approach is off goal, making students into passive recipients of information (Prasetyo et al., 2021).

This is where the role of student worksheet comes. The activities in student worksheet can be modified as needed precisely by applying cases in everyday life that students often encounter or read through the internet into learning, especially biology. In addition, by providing the application of cases into learning, students can also relate them to existing concepts and add information to support the truth of the case through factual information that can be obtained on the internet such as the results of research journals. That way, starting from working on student worksheets, students' abilities and characters are also developing.

However, based on the results of researcher observations and interviews with several students at SMA Negeri 4 Berau, especially in class XI, some problems in learning are that the teacher tries to maximize students on theoretical explanations so that practical learning cannot be optimal. In addition, the lack of student interest in working on students worksheet despite the long collection deadline is because the tasks given on students worksheet refer more to individual tasks than group tasks so that students have difficulty answering some questions that they do not understand. Students' sense of responsibility has also decreased because the assignments given are personal assignments so that students more often stall the collection time. Post-pandemic group activities are also still limited where students only do one group learning in the odd semester.

Another problem is also found in the questions giving by the teachers which still ranges from C2 to C3 and sometimes C4 so that it does not require students to investigate even though the students' abilities that teachers need to emphasize are C4, C5, and C6. In addition, the lack of application of everyday events in students worksheet also makes students not familiar with questions above C4. In fact, linking the concepts that have been obtained with cases in everyday life can encourage students to think broadly and deeply about the material being taught, knowledge will also be easier to distribute to students compared to memorizing. A deeper understanding of concepts will enable students to implement the knowledge they have which is useful for finding solutions to new problems in other situations (Amin et al., 2018). Therefore, researchers want to develop this research so that it can provide motivation and alternatives for teachers in making student worksheets more advanced.

Student worksheet which contains the steps oflearning model its orientation can improve students' abilities in analyzing, problem-solving, and scientific work (Yulkifli et al., 2019). Furthermore, Nuha et al. (2023) explained that science process skills can be improved by applying science learning based on learning activities guided by worksheets. One of the learning models that can be applied in making this student worksheet is Investigation Based Scientific Collaborative (IBSC). IBSC is collaborative learning that aims to train students' communication and collaboration skills through positive dependence among students by fostering empathy from high-ability students to low-ability students (Suharti et al., 2019). In collaborative learning, participants have a responsible role and are more comfortable to generate ideas, share knowledge, and solve problems together with their group members, supporting and relying on each other in the learning process to gain new knowledge. And develop a deeper understanding of the subject matter (Lu & Smiles, 2022).

The IBSC learning model consists of five syntaxes, namely (i) motivation and problem orientation, (ii) collaborative investigation sharing task, (iii) present/presentation, (iv) collaborative investigation jumping task, and (v) evaluation. This model is designed to maximize the role of the teacher as a mediator and facilitator in both phases to facilitate positive

dependence that will encourage communication and cooperation between students, so as to train students' communication and collaboration skills in learning (Suharti et al., 2019). In the IBSC model, students are asked to solve a main problem in collaboration by solving sub-problems first according to their expertise. Thus, communication will occur between group members (Fakhrudin & Suharti, 2021).

Student worksheet based on IBSC are also expected to help students in meeting their needs to be able to improve 21st century skills. The US-based Apollo Education Group identified ten skills needed by students to work in the 21st century, namely critical thinking skills, communication, leadership, collaboration, adaptability, productivity and accountability, innovation, global citizenship, entrepreneurship skills and spirit, and the ability to access, analyze, and synthesize information (Zubaidah, 2016). From this, it is known that knowledge alone is not enough for students to compete in the 21st century but other skills both applicative to social skills are also needed such as science literacy and collaborative skills.

Through the syntax of the IBSC model, the development of student worksheets based on the IBSC model is expected to improve collaboration skills through jumping task and sharing task, while scientific literacy skills, including the ability to access, analyze and synthesize information, can be improved through investigation syntax in IBSC model. The implementation of activities in the student worksheet is also adjusted to scientific literacy indicators to maximize the increase in both competencies.

Broadly speaking, scientific literacy is the ability to understand how science is practiced, how scientific knowledge is obtained, and how science is distinguished from other types of knowledge (Boury et al., 2021). Meanwhile, PISA defines it as the ability to use scientific knowledge, identify questions, and draw conclusions based on evidence, in order to understand and make decisions regarding nature and changes made to nature through human activities (Yuliati, 2017). Science literacy is simply defined as the ability to understand science and its applications (Rahmania et al., 2015).

Changes in aspects of life affect decision-making processes at the individual and societal levels. The ability to identify, address and solve science and technology problems is part of science literacy. For the development of science and science literacy, science education is essential. Because it is the key to positive social change, developing positive attitudes towards the environment, and engaging individuals in efforts towards sustainable development (Klemencic et al., 2023). The Program for International Student Assessment (PISA) is a study to evaluate the education system followed by more than 70 countries around the world held by the OECD every 3 years. The results of the PISA study in 2022 released by the OECD showed that the average ability of Indonesian students in science reached 383 with the OECD global average score of 485. From these results, it can be seen that students' science scores are still low from the OECD average score and decreased from the 2018 score of 389. Whereas science literacy is one of the competencies needed in the 21st century.

Science literacy is something that is still unfamiliar to both teachers and students of SMAN 4 Berau, the research location. Thus, the application of science literacy in learning is still less visible. Science literacy is a person's ability to understand science concepts and their applications, which includes using this knowledge to identify questions and draw conclusions based on existing evidence and data. This can be considered easy for students who have a high level of understanding while for students who have a low level of understanding, activities such as identifying questions or concluding evidence can be considered something difficult. For this reason, collaboration skills are needed to enable students to share, exchange ideas and provide information and understanding to each other so that this ability can be achieved. In addition, in an era where information is widely spread whether it is based on facts or not, one needs the ability to distinguish and understand the truth of information so as not to believe in false information.

One of the elements in science literacy is cognitive ability where the school learning context is directed to focus on the skills and strategies needed to read science texts (Croce & Firestone, 2020), so that it does not only emphasize memorization of knowledge but it also oriented towards the process and achievement of scientific attitudes (Yuliati, 2017). Science literacy focuses on the development of learning skills, investigation, and transfer of expertise so that the younger generation is able to use the knowledge and skills acquired in daily and professional activities (Virtic, 2022).

In science teaching and learning, teachers usually engage students in hands-on experiences as well as text-based literacy practices that focus on concepts, especially those that include reading, writing and discussion. During the science inquiry process, science becomes a place for students to use literacy as an inquiry tool, and to hone their skills in reading and writing such as seminars, journals or research reports (Tai et al., 2020).

Gormally et al. (2012) describes there are ten indicators of science literacy. The first indicator is understanding inquiry methods that lead to scientific knowledge. Second indicator is identification of valid

scientific arguments. The third one is evaluating the validity of sources. The fourth indicator is evaluating the use and misuse of scientific information. The fifth one is understanding research design elements and their effect on scientific findings or conclusions. Then, the sixth is organization, analysis and interpretation of quantitative data and scientific information. The seventh indicator is creating graphical data. The eight indicator is reading and interpreting graphical data representations. The ninth indicator is solving problems using quantitative skills including probability and statistics. Next, the tenth is understanding and interpreting basic statistics and the last indicator is justifying inferences, predictions and conclusions based on quantitative data.

Research from Lutfiah et al. (2021) regarding the application of the IBSC model to students' thinking skills concluded that there was an increase from pre-test to post-test results when using this IBSC model. These results are also in line with Fakhrudin & Suharti (2021) research which revealed that the value of students' critical thinking skills increased after using this learning model. From these studies, researchers also want to test the same model but with different cognitive abilities, namely science literacy.

In addition to science literacy skills, Suharti et al. (2019) revealed that the IBSC learning model is intended to improve collaboration skills, which is one of the important skills in the 21st century. Collaboration skills are one of the skills that propose the effectiveness and fairness of working in groups to solve problems in completing collective tasks so as to achieve common goals and create social ties (Ekeh, 2023; Fajariningtyas et al., 2021). In this situation, there is a division of authority and acceptance of responsibility among the group (Laal, 2012). In addition, there is also an exchange of thoughts and feelings between students who are on the same level as each other (Lelasari et al., 2017), as well as increasing activeness and communicative skills in cooperation and compromise (Junita & W, 2020).

In collaborative learning, a teacher serves as a guide or moderator for students and assists them during collaborative learning activities. If the given task is not relevant, the teacher is responsible for changing the task based on the purpose of the task (Azar et al., 2021). In addition, during the collaborative learning process, the teacher can be an assistance provider to accelerate the learning process by offering timely assistance, feedback, and guidance, monitoring team progress as well as resolving relationship conflicts when team members cannot resolve conflicts within the team (Brannen et al., 2021).

The collaborative investigation stage of sharing tasks contained in the syntax aims to help low-ability students get a better learning leap and make it easier for them who have difficulty completing the task. This is because sometimes students will find it easier to understand when their friends explain material that they do not understand. Meanwhile, for students who explain, they will have a stronger and longer memory on the topic (Asari, 2017). Meanwhile, jumping task collaborative investigation is part of Lesson Study for Learning Community (LSLC), where students are required to think critically, creatively and differently in solving this high-level task (Hobri et al., 2021). From this, students will be given the right to collaborate and be responsible for group tasks. In addition, there will be a change in the role of students, especially those who consider teachers and textbooks as the only source of learning (Chang-Tik et al., 2022).

The difference between collaborative and cooperative problem solving is that while cooperation is achieved from the division of labor among members, as an activity where everyone is responsible for part of the problem solving, collaboration is a coordinated and synchronized activity that is the result of an ongoing effort to build and maintain a shared conception of a problem (Baker, 2015).

In a discussion that allows for heterogeneous grouping, collaboration can also balance the discussion as male and female learners have significantly different interactions during collaborative learning. Female students engage in more verbal interactions and are better at communicating with peers to share opinions, and prefer to listen and integrate the opinions of their groupmates. Meanwhile, male students preferred non-verbal interactions to verbal interactions, and, in particular, more irrelevant behaviours appeared during their collaboration such as fidgeting, joking, and singing, which are often forms of spontaneous and unconscious communication (Feng et al., 2023).

The pandemic situation that has just ended makes the human respiratory system the most suitable learning material to be tested in addition to the immune system. From this material, students can develop their skills, especially science literacy abilities by utilizing the problems that exist during the pandemic and after the pandemic by analyzing the problem and combining it in a scientific report. In addition, the respiratory system is one of the materials that is closest to everyday life, for example, the higher percentage of people who smoke which can lead to high sufferers of diseases related to the respiratory system. The ease of finding respiratory system problems in life is one of the reasons why the application of IBSC based student worksheet is used in this material. Especially the main goal is to improve students' science literacy and collaboration skills.

Method

Research Design

The type of this research was research development model (R&D) developed by Dick and Carry, consisted of five stages; Analysis (A), Design (D), Development (D), Implementation (I) and, Evaluation (E) also known as ADDIE development method (Gustiani, 2019). These five stages were done systematically and evaluated on each stage to obtain optimal results. In addition, this model is used because it has a simple procedure and makes the work to build products easier (Agustian & Setiawan, 2024).

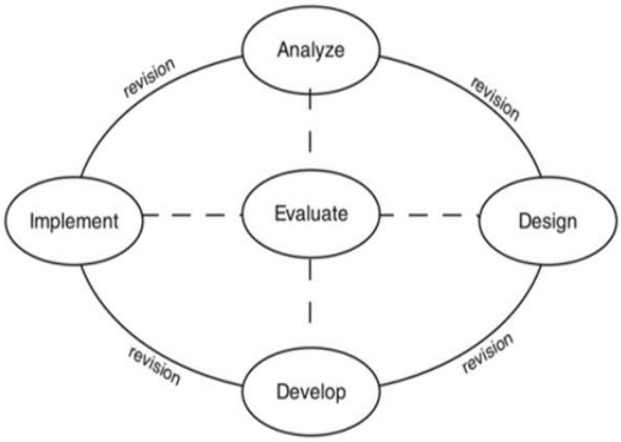

Figure 1. The model of ADDIE stage by Branch

This study used a pretest-posttest control group design which is type of research that provides a pretest before being given treatment, the results of the treatment will be known in a more careful way. This can be known by knowing a comparison through the condition before being treated with the condition after being treated (Putri & Wulandari, 2022). This study used one class as a limited trial and two classes in field trials, namely the control class and the experimental class.

Subject and Location

This research was conducted at SMAN 4 Berau which is located at Bukit Berbunga Street KM 1, Sambaliung, East Kalimantan. The population in this study were students of class XI and class XII. 23 students of class XII who became respondents in the limited trial and 60 students of class XI, each class consisting of 30 students became respondents in field trial. Research sampling using simple random sampling or random sampling regardless of the existing strata or without consideration. In this study, the control class used student worksheet provided by the teacher and adapted to the inquiry learning model while the experimental class used IBSC-based student worksheet

Instrument

The data collection instruments used in research on the development of IBSC based student worksheet are validation sheets for experts, teachers and students who have studied respiratory system material, which each validation sheet has its own assessment aspects. Meanwhile the instruments used in this research are literacy test sheets, collaboration skills questionnaires and observation sheets.

Development Design

In this research, the procedure for developing IBSC based student worksheet consists of the five stage. The first one is analysis. In this stage the researcher finds out the problems that occur in biology learning at school and analyzes the information in order to get solutions to existing problems so as to improve the learning outcomes of students. Curriculum analysis also needs to be done to identify the depth and breadth of competencies that must be developed. The second is design stage, which consists of 2 activities, namely the preparation of the material framework design that needed in developing learning media and preparation of instrument that will be used to assess the student worksheet to be developed. The third is development stage consisted of 3 activities, namely developing IBSC based student worksheet, developing system respiratory handbook, and developing research instruments. The fourth is implementation stage consisted of limited trials and field trials. And the last one is the evaluation stage which looks the results of the validity and the practicality of student worksheet and the effectiveness of student worksheet on students' literacy science and collaboration skills. The data analysis technique used in this research aims to assess the quality of the developed student worksheet, includes:

Descriptive Analysis

Qualitaive Data Analysis

This techniques used to analyze of qualitative data namely in the form of assessing the validity and practicality of IBSC based student worksheet by experts, biology teachers, and students' responses to it.

Quantitative Data Analysis

Besides being assessed descriptively, the validity and practicality of the IBSC based student worksheet, as well as the research instruments were also assessed quantitatively, where the results obtained will be converted into product quality categories according to the assessment guidelines such as the following table:

Table 1. Determination of Product Criteria Intervals (Widyoko, 2011)

Score range	Grade	Criteria
$X > (\bar{X_i} + 1.8Sb_i)$	A	Very good
$(\bar{X_i} + 0.6Sb_i) < X \leq (\bar{X_i} + 1.8Sb_i)$	B	Good
$(\bar{X_i} - 0.6Sb_i) < X \leq (\bar{X_i} + 0.6Sb_i)$	C	Sufficient
$(\bar{X_i} - 1.8Sb_i) < X < (\bar{X_i} - 0.6Sb_i)$	D	Insufficient
$X \leq (\bar{X_i} - 1.8Sb_i)$	E	Very insufficient

Information:
X = Empirical score
X_i = ideal mean (1/2(maximum score + minimum score))
Sbi = ideal standard deviation (1/6(maximum score – minimum score))

IBSC based student worksheet as well as test instrument, declared valid or practical if they meet the minimum category of "Good".

Test Instrument

Analysis data on students' literacy science and collaborative skills tests were collected in the form of pretest and posttest results. Before testing the hypothesis, a prerequisite test is carried out first. This prerequisite test includes multivariate normality tests, and multivariate homogeneity tests. The multivariate normality test used the Mahalanobis distance, the multivariate homogeneity test used box's M test and the multivariate hypothesis test used the Manova test. In addition, to determine the more significant increase in knowledge between the control class and the experimental class on both variables, the n-gain test was used.

Result and Discussion

The result of the analysis (A) stage through interviews with science teachers in junior high schools shows that teachers focused on conveying concepts while for practice problems, teachers usually give take-home assignments to students. Questions on assignments also still focus on the C1-C3 in the cognitive domain and sometimes C4, while C5 and C6 type questions have never been used. In addition, based on the observation of questions from the pandemic period, the questions are more oriented towards theoretical knowledge questions while the application in everyday life is still lacking, as well as questions related to scientific skills.

Both during the pandemic and post-pandemic, the tasks done by students also dwell more on individual tasks so that the opportunity to see student cooperation in solving a problem is reduced. Group learning carried out by students during the post-pandemic period was only carried out on reproductive system material so that the exchange of opinions between students was still rare. Even though based on interviews, students prefer to do group learning According to the Biology teacher, another material that needs to do group learning is the human respiratory system because in addition to being one of the systems closest to humans, the human respiratory system is also the most related to everyday life. But because of the time that doesn't match, group learning of this material has not been done. Therefore, the author intends to develop student worksheet for this material which is adapted to the curriculum used by the school, namely the 2013 curriculum, especially for class XI and class XII students.

Furthermore, the Design (D) and Develop (D) stages are carried out based on the results of the initial stage. These stages obtain designs and products of learning tools for human respiratory system material including handout, IBSC based student worksheet, literacy science test, questionnaire of collaboration skills.

Handouts are used for control classes and experimental classes as additional supplements that need to be read and understood by students before learning respiratory system material in groups. This handout was created using Microsoft Word and Canva by determining the contents of the book with combining several book references such as printed books that are often used by students, digital books that are often used by teachers and several other references. Respiratory system handout containing 18 pages in pdf format which can be downloaded via link or scanned via qr code. The structure of the handout includes introduction, body and conclusion.

The introduction of this handout contains cover, preface, basic competencies, indicators and learning objectives. The cover and background of this handout were designed using the Canva application with a cover consisting of the title, class and name of the compiler of the handout. The content section contains a concept map and learning materials that include definiton, respiratory organs, respiratory mechanisms, respiratory frequency and abnormalities in the respiratory system. Meanwhile, in the closing section consists of a bibliography containing a list of references or sources used for the preparation of human respiratory system handouts. The screenshot of handout can be seen in Figure 2.

Figure 2. The screenshot of respiratory system handout in Indonesian language

The characteristics of the developed student worksheet are based on the IBSC learning model developed by (Suharti et al., 2019). Investigation Based Scientific Collaboration (IBSC) is collaborative learning that aims to train students' communication and collaboration skills through positive dependence among students by fostering empathy from high ability students to low ability students (Suharti et al., 2019).

Gormally et al. (2012) nine indicators are used in making student worksheet questions. One of them is being able to distinguish valid sources. SMAN 4 Berau is one of the schools in Berau Regency, where students are allowed to use smartphones during biology learning activities which previously had to have permission from the school curriculum first. For this reason, the indicator is included so that when working on student worksheet in the future, students can have more learning resources, especially in this globalization era and can sort out the sources used. Basically, the development of student worksheet is expected to be able to develop the ability of science literacy and collaboration skills of students such as using the type of questions that linked learning activity with the scientific approach and are done in groups.

IBSC based student worksheet is made using Microsoft word because the purpose of this research is to introduce science literacy questions, so that it is made simple like student worksheet made by teachers in general to keep the student's focus remains on the given questions. The question made by referring to the science literacy indicators made by Gormally et al. (2012). After analyzing the questions from the indicators, the worksheet questions were made according to the number of indicators, namely 9 questions.

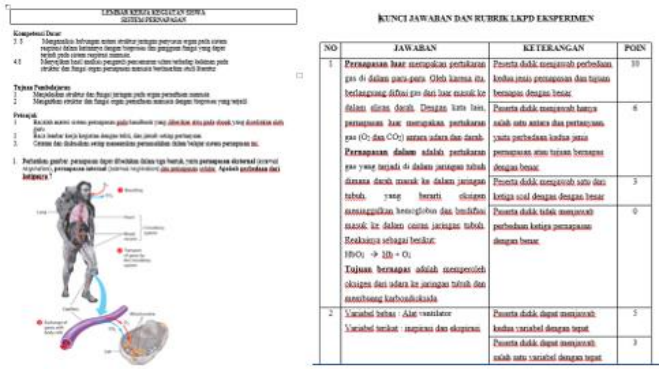

Figure 3. The screenshot of IBSC based student worksheet in Indonesian language

This worksheet consisted of title, basic competencies, learning objectives, work instructions and questions. Then to complete this worksheet, an assessment rubric is also made which consist of answer keys, points, indicators of giving points and how to calculate scores. The experimental student worksheet was made based on the control student worksheet made by the teacher by adjusting the theme or sub-material discussed and the science literacy indicators. The screenshot of IBSC based student worksheet can be seen in Fig 3.

The questions on the science literacy test were made like IBSC based student worksheet by analyzing science literacy questions from Gormally et al. (2012) and then adjusted to science literacy indicators. The questions made amounted to 10 questions in the form of multiple choice accompanied by arguments so that each student who chose a particular answer had to provide reasons why the answer could be chosen. The selection of question with this type because Multiple-choice questions (MCQs) are one form of question that is easy to applied and can save time in its assessment. However, its weakness that students can make guesses to get the answer. One form of question that can minimize the existence of guesses answers by students is reasoned multiple choice questions or reasoning multiple choice questions (RMCQs). This form of question can train students to think critically, find problems and solutions accompanied by well-founded and logical reasons (Saputri et al., 2022). The assessment rubric for science literacy questions made also has different criteria and points for each question according to its difficulty.

Furthermore, the collaboration skills questionnaire was made based on a modification of 10 aspects revealed by Laal (2012), namely roles in groups, self-advocacy, working with others, contributions, time management, compromising, respecting opinions, solving problems,

research techniques and synthesis. From this aspect, criteria are then created and given 1-4 points for each aspect. This collaboration questionnaire consists of a questionnaire title, instructions for filling in, learner identity, questionnaire, additional comments and signature.

The Result of Expert Validation Test

This process is a series of Develop (D) stage which is before being applied in the classroom, the product must be declared valid through validation experts. Validation serves to assess the validity of the developed student worksheet and instrument. This assessment includes aspects of question validity. This test used validity questionnaire. IBSC based student worksheet and science literacy test will be assessed using Likert scale with 4 alternative choices, namely 4 (very good), 3 (good), 2 (not good), 1 (not good), and 2 (not good). Meanwhile, the collaborative skill questionnaire using a 1-5 scale consisting of strongly agree, agree, netral, disagree, and strongly disagree. Data on the validity results of the expert's assessment can be seen in Table 2, Table 3 and Table 4.

Table 2. The Expert's Validation for IBSC based Student Worksheet

Assessment aspect	Rating results	Eligibility category
Student worksheet eligibility	12	Good
Student worksheet accuracy	10	Good
Didactic	15	Good
Construction	31	Very good
Technical	12	Very good

Based on Table 2, the results of the assessment on the validity aspect of the student worksheet get a score of 12, the accuracy aspect of the student worksheet gets a score of 10, the didactic aspect gets a score of 15 with a good eligibility category. Meanwhile, the construction aspect scored 31 and the technical aspect scored 12 with a very good eligibility category.

Table 3. The Expert's Validation for Science Literacy Test

Assessment aspect	Rating results	Eligibility category
Content	13	Good
Construction	16.20	Good
Language	6	Good

Based on the assessment results in Table 3, the assessment results on the content aspect, construction aspect and language aspect show a good category with an assessment score of 13, 16.2 and 6 respectively. From the expert lecturer's assessment, no comments or suggestions were given.

Table 4. The Expert's Validation for Collaborative Skills Questionnaire

Assessment aspect	Rating results	Eligibility category
Clarity	13	Very good
Content accuracy	12	Good
Content validity	3	Good
No bias	3	Good
Language accuracy	11	Good

Based on the assessment results in Table 3, the results of the assessment of the collaboration skills questionnaire, namely in the aspect of clarity getting the assessment results with a score of 13 and a very good category, meanwhile in the aspect of content accuracy, content validity, no bias and language accuracy the assessment show a good category with assessment score are 12, 3, 3, and 11 respectively.

It is concluded that the validity assessment of the IBSC based student worksheet, science literacy test, and questionnaire of students' collaboration skills shows that the products are valid to use to measure students' skills without revision as assessed by expert lecturers and it is suitable for limited trial use.

Implementation

At the implementation stage, the product that has been developed and validated will be tested with 2 process. The first one was carried out in limited trial class which is XII 3 SMAN 4 Berau that consist 23 students and the second one was carried out in field tests in con in the control and experimental classes, namely class X1 and X2.

Small Group Trial Results

Small group trial or limited trial was conducted on 23 students of XI 3 SMAN 4 Berau who had previously gone through the process of learning respiratory system material. students were asked to work on science literacy test and collaborative skills qustionaire and continued by filling out a questionnaire to find out how students responded about the product practicality. The results of the limited trial conducted at SMAN 4 Berau are as follows;

Practicality of IBSC based Student Worksheet on Practitioners' Assessment and Student

The assessment carried out by biology teachers in SMAN 4 Berau and student. The recapitulation of assessment on biology teachers and students at SMAN 4 Berau and students can be seen in table 5 and 6.

Table 5. Teacher's Pracicality Result for IBSC based Student Worksheet

Assessment aspect	Rating results	Eligibility category
Student worksheet eligibility	10.50	Very good
Student worksheet accuracy	6.50	Good
Didactic	24	Good
Construction	26.50	Good
Technical	9	Good

Table 6. Students Pracicality Result for IBSC based Student Worksheet

Assessment aspect	Rating results	Eligibility category
Presentation	10.80	Very good
Language	10.30	Very good
Content validity	10.90	Very good
Usability	18.30	Very good

Based on Table 5, it is obtained that the assessment carried out by biology teachers for IBSC-based student worksheet, namely in the aspect of feasibility of the question, the assessment results are obtained with a score of 10.5 and a very good category, meanwhile the accuracy, the didactic, the construction and the technical aspect are obtained a score of 6.5, 24, 26.5 and 9 respectively with a good category. From these results it can be concluded that the student worksheet according to the biology teacher is practical to use but with some improvements.

Furthermore, based on Table 6, it is obtained that the assessment made by students for IBSC based student worksheet, namely in the presentation, the linguistic, the content validity and the usability aspect, the assessment results are obtained a score of 10.8, 10.3, 10.9 and 18.3 respectively with a very good category. From these results it can be concluded that the student worksheet according to students is practical to use.

Most students also wrote in the questionnaire comment column that the IBSC-based student worksheet has interesting questions because it is the first time students have worked on questions of that type. In addition, because the problem is relatively difficult, the possibility of discussion is also higher. In line with Sucipto et al. (2024) who explain that complex problems provide opportunities for learners to go different ways, look for alternative solutions, and realize their potential to produce different solutions. They interact and collaborate with each other to determine problems to be solved and distribute their respective tasks, discuss, and present the results in class discussions responsibly. In group work, team members ask each other questions to better understand the problem in depth and each group member gives other members the opportunity to convey their ideas.

Practicality of Science Literacy Test and Collaborative Skills Questionnaire on Practitioners' Assessment and Student

The assessment for practicality of science literacy test and collaborative skills questionnaire carried out with the same way as IBSC based student worksheet which is used practicality questionnaire with specific aspect. The recapitulation of assessment of science literacy test on biology teachers and students at SMAN 4 Berau and students can be seen in table 7 and 8. Meanwhile, the recapitulation of collaborative questionnaire can be seen in table 9 and 10.

Table 7. Teacher's Pracicality Result for Science Literacy Test

Assessment aspect	Rating results	Eligibility category
Content	17	Very good
Construction	21.50	Very good
Language	8	good

Table 8. Student's Pracicality Result for Science Literacy Test

Assessment aspect	Rating results	Eligibility category
Content	17.80	Very good
Construction	22.30	Very good
Language	9.40	Very good

Based on Table 7 and 8, it is obtained that the assessment carried out by biology teachers and students for science literacy, namely in the aspect of content and construction were obtained with a score of 17 and 21.5 respectively for teacher and 17.8 and 22.3 respectively for students. Both aspect also receives a very good category. Meanwhile the languange aspect was obtained a score of 8 with a good category from teacher and score 9.4 with a very good category from students. From these results it can be concluded that the science literacy test is practical to use.

Table 9. The Teacher's Validation for Collaborative Skills Questionnaire

Assessment aspect	Rating results	Eligibility category
Clarity	12	Good
Content accuracy	13	Very good
Content validity	4	Good
No bias	4	Good
Language accuracy	13	Very good

Table 10. The Student's Validation for Collaborative Skills Questionnaire

Assessment aspect	Rating results	Eligibility category
Clarity	13.60	Very good
Content accuracy	13.40	Very good
Content validity	4.40	Very good
No bias	4.30	Very good
Language accuracy	13.80	Very good

Based on Table 9 and 10, it is obtained that the assessment for collaborative skills questionnaire which carried out by biology teachers and students, namely in the aspect of content accuracy and language accurace were obtained with a score of 13 in both aspect for teacher and 13.4 and 13.8 respectively for students. Both aspect also receives a very good category. Meanwhile the clarity, no bias and content validity aspect were obtained a score of 12, 4, and 4 respectively with a good category from teacher and score 13.6, 4.3 and 4,4 respectively with a very good category from students. From these results it can be concluded that the collaborative skills questionnaire is practical to use.

In addition to using the ratio interval formula, to determine the practicality of an instrument or product can use descriptive analysis based on the results of observations on the implementation of the use of research products or instruments. In this study, the observer who is a school biology teacher stated that during the IBSC-based student worksheet and the processing of science literacy test and collaboration skills questionnaires, no students asked about the questions or statements given in the instrument or student worksheet, which means that the grammar used is in accordance with what students understand. In addition, students also did not ask questions about the method of using these products and instruments, which means that the instructions for use provided on the products and instruments are clear to explain how to use the products and instruments. Proper language use is a feature of good scientific communication. So they need to be designed using the correct language rules, can be read correctly, have clear information, and use effective and efficient language appropriate to the student's level of ability (Nuha et al., 2023).

The Result of Effectiveness Test

In the Implementation (I) stage, IBSC based students worksheet is applied in classroom learning and completed out by students through group learning Group selection in research using shuffling method makes students find new members in one group and have heterogeneous groups. In accordance with the opinion of Walston & Johnson (2022) diverse teams tend to avoid thinking by interrogating the actions of other members objectively. Differences in age, personality, and gender can be highly synergistic or harmful to teamwork. To reduce conflict and maintain unity within the group, the optimal group size is four to six people.

The effectiveness test was carried out in a limited way through pre-test before using the worksheet and post-test after using the worksheet. For the 30 students who took part in the classroom learning, the average result of the pre-test was 16.10 and the post-test was 47.06 for control class and the average results of pre-test was 15.68 and the post-test was 61.52 for experimental class.

Table 11. The Result of Normality Test

Class	Sig	Correlation
Pretest for science literacy and collaborative skills experimental class	0.000	0.981
Pretest science literacy and collaborative skills control class	0.000	0.974
Posttest science literacy and collaborative skills experimental class	0.000	0.935
Posttest science literacy and collaborative skills control class	0.000	0.947

The normality test was also done to find out whether the data was normally distributed or not. The normality test was carried out with Mahalanobis Distance. The results are shown in Table 11. From Table 11, if the correlation coefficient > r table or sig. < 0.05 then there is a significant correlation. In the pretest of the experimental class and control class, students' science literacy and collaborative skills had a significance value of 0.000 and a correlation coefficient value of 0.981 and 0.974 respectively, which showed a very high correlation coefficient meaning that the data came from a sample that was normally distributed multivariate. The same thing also applie in the post-test of the experimental class and control class which had a significance value of 0.000 and a correlation coefficient value of 0.935 and 0.947 respectively.

The homogeneity test serves to determine whether two or more covariance matrices are equal (homogeneous). The testing assumption of the Box M Test is that the data must have been proven to be multivariate normally distributed (Hahs-Vaughn, 2016). Because the data has been proven to be normally distributed, this homogeneity test can be carried out. The results can be seen I table 12.

Table 12. The Results of Homogenity Test

Test type	Class	Significance
Box's M	Pretest	0.000
	Posttest	0.000

Based on table 12 shows that both significance values are less than 0.05 which is 0.000, so it can be concluded that the covariance variance matrix of the dependent variable is not the same. However, in the opinion of Johnson & Wichern (2007) although the hypothesis is not accepted, the Manova test can still be carried out as usual, so that the hypothesis testing is continued using the Manova test with Pillai's Trace.

Pillai's trace is selected because in multivariate analysis there are several types of test statistics that can be used, namely Pillai's Trace, Wilk's Lambda, Hotelling's Trace, and Roy's Largest Root. The selection of the Pillai's trace test is because this test is suitable for use if the assumption of homogeneity of the variance-covariance matrix is not met, the sample size is small and if the results of the test contradict each other, namely if there are some average vectors while others are not. Meanwhile, Wilk's Lambda test is a suitable test statistic to use if there are more than two groups of independent variables and the assumption of homogeneity of the variance-covariance matrix is met. Hotelling's Trace test is a suitable test statistic if there are only two groups of independent variables and Roy's Largest Root test is a test statistic that is only used if the assumption of homogeneity of variance-covariance is met (Purnomo, 2022).

The linearity test is used to determine a significant linear relationship of the variables of student's science literacy ability and collaboration skills. The linearity test can be done through a test of linearity where a significance value of 0.311 is obtained, which means that the significance value is greater than 0.05 or 0.311 <0.05, so H_0 is rejected, meaning that there is a linear relationship between science literacy skills and students' collaboration skills.

To measure the extent of the relationship between the two variables that are declared linear, the correlation test is used. This correlation test was carried out by looking at the results on the post-test of science literacy and collaboration skills then analyzed using the Pearson Correlation test. The results of this correlation test can be seen in the table 13 while the interpretation of the r value can be seen in the table 14.

Table 13. The Result of Correlation Test

Test type	Significance	Correlation
Pearson	0.005	0.491**

Table 14. The Interpretation of The R Value (Alaloul et al., 2021)

Score range	Interpretation
0.80 – 1.00	Very strong
0.60 – 0.79	Strong
0.40 – 0.59	Moderate
0.20 – 0.39	Weak
0.00 – 0.19	Very weak

Based on the table 13 and 14, it is known that the sig value. (2-tailed) < 0.05 or 0.005 < 0.05 so it can be said that there is a positive and significant relationship between science literacy and collaboration skills on the human respiratory system. In addition, it is known that the Pearson Correlation value (r count) is 0.491. Based on the correlation interpretation regarding the level of relationship between science literacy and collaboration skills on the human respiratory system, it can be seen that the correlation between the two variables is quite strong. Then the sign (*) on the correlation coefficient also provides an interpretation indicating that there is a unidirectional relationship between the two variables, meaning that the relationship between the two is directly proportional (Stockemer, 2018). This means that the higher the students' science literacy skills, the higher their collaboration skills.

Furthermore, to measure the effect of independent variables or to calculate the significance testing of differences in means simultaneously between groups for two or more dependent variables, the manova test is used (Purnomo, 2022). The manova test was carried out after the prerequisite tests for multivariate normality and multivariate homogeneity were fulfilled. The result of manova test can be seen in the following table

Table 15. The Result of Manova Test

Test type	Significance
Pillai's trace	0.000

Based on Table 15, it is known that the Pillai's Trace test results have a sig value. 0,000 < 0,05. This means that H_0 is rejected, which means that there is a significant difference in the ability of science literacy and collaboration skills of grade XI students who use and do not use IBSC based student worksheet. The availability of student worksheet is one of the factors that can improve students' understanding and skills so that they can improve their competence (Yulkifli et al., 2019). The scientific approach to curriculum which focus on student-orinted, requires students to take an active role in the learning process. This will be easier if combined with teaching materials in the form of student worksheets (Supriyadi et al., 2021).

This difference also can be seen from the results of the between-subject effects test which can be seen in the table 16

Table 16. The Result of Between-Subject Effect

Variable	F	Sig.
Science literacy	21.928	0.000
Collaboration skills	6.774	0.012

From the table above, it is known that the results of the Between-Subject Effects test on the science literacy variable have a sig value. 0,000 < 0,05 and on the collaboration skills the sig value. 0.012 < 0.05. This means that there is a significant difference in the science literacy and collaboration skills of grade XI students who use and do not use IBSC based sudent worksheet. The difference can be seen from the N-gain test.

Table 17. The Result of N-Gain Test

	Science literacy		Collaboration skill	
Value	Control	Experiment	Control	Experiment
Lowest score	13.70	35.29	11.11	38.89
Highest score	56.84	86.20	100	100
Average score	36.79	60.57	48.57	62.58
Gain score Category	Ineffective	Effective enough	Less effective	Effective enough

Herayanti et al. (2022) stated that the efficacy of instructional materials created by researchers can be determined by evaluating the extent to which students' comprehension of concepts improves, as indicated by the results of the N-Gain test administered before and after the instructional intervention. Based on the results of the N-Gain score calculation above, it shows that the average value of science literacy in the control class is 36.79% with the highest value of 56.84 and the lowest value of 13.70. Based on the results of the interpretation of the N-Gain value, the value in this control class is included in the ineffective category. While in the experimental class the average value of science literacy is 60.57%, with the highest score of 86.2 and the lowest score of 35.29. Based on the results of the interpretation of the N-Gain value, the value in this experimental class is in the moderately effective category.

In the collaboration skills variable, the average value in the control class was 48.57% with the highest value of 100 and the lowest value of 11.11. Based on the results of the interpretation of the N-Gain value, the value in this control class is in the effective category. While in the experimental class the average value of collaboration skills is 62.58%, with the highest score of 100 and the lowest score of 38.89. Based on the results of the interpretation of the N-Gain value, the value in this experimental class is in the moderately effective category. So it can be concluded that using IBSC is more effective in improving students' science literacy and collaboration skills.

The increase in science literacy skills and collaboration skills of students in the experimental class has a higher average value than the control class, from the results of calculations using the Normalized Gain Score (N-Gain) on the pretest and posttest the value obtained in the experimental class is classified as quite effective. When viewed in general as the previous descriptive analysis, it can be seen that the value of variables in the control class also increased, although in the N-Gain results the increase was proven to be ineffective to less effective in improving students' science literacy and collaboration skills. This could be due to the opinion of Subali (2010), namely the test effect, because the learning media experiment was carried out in a short time, so that students still remember pretest questions that are similar to posttest questions.

The thing that makes the IBSC based student worksheet more effective than the student worksheet used in the control class is because, as previously described, the characteristics and syntax of IBSC are in accordance with the abilities to be assessed. In accordance with Husna et al. (2022), learning which emphasizes the process of seeking knowledge has a positive influence on increasing students' scientific literacy skills.

This is in line with research from Lutfiah et al. (2021) where uses that the IBSC learning model has an effect in improving students' thinking skills because the syntax of investigative activities contained in learning activities can allow students to conduct investigations so that they will foster student creativity through developing ideas, connecting different ideas, and formulating ideas in solving problems. He et al. (2023) classified the cognitive presence of a community in their enquiry model into triggering events, exploration, integration, and resolution, Implementation of sharing and jumping tasks learning which is the syntax of IBSC can foster students' creative thinking skills (Zestia & Nahadi, 2022).

One of the initial syntaxes that supports the increase in science literacy is sharing tasks. sharing tasks are individual tasks given by the teacher that can be completed with small groups that have been formed by the teacher. Usually, sharing task questions contain questions that students usually get at school during lessons. Sharing task questions are at the C1, C2, C3 levels on Bloom's taxonomy. Therefore, through sharing tasks, students can benefit even though the student's

ability level is low, medium or high. In this case, the activity of sharing tasks will encourage students to have more open-minded thinking (Murtikusuma et al., 2022).

The existence of jumping task syntax in learning affects students' thinking process because students feel challenged to study harder in order to solve problems correctly. Jumping tasks have a positive impact, where students feel more challenged and motivated to study harder independently and discuss with friends, increase self-confidence and improve creative and critical thinking skills (Lutvita et al., 2020). Students with critical thinking skills can establish their basic skills and fullfill the aspects of focus, reason, inference, and situation through process of learning which students are guided to defend the argument they had by giving a reason (Melawati et al., 2022; Trapsilasiwi et al., 2023). From this statement, it can be said that this is one of the causes of increased scientific literacy because of the many ideas that arise coupled with questions that are also associated with scientific methods.

While the improvement in collaboration skills is in line with the statement that working on sharing tasks will create good communication between student (Fauziyah et al, 2021) and in learning activities, jumping task-based problem solving affects the activities and ways of thinking of students who initially tend to be individual by ignoring friends to become active students in learning by caring for each other and sharing their knowledge, thus stimulating students to be more active in class (Lutvita et al., 2020). Jumping tasks also have a positive impact, where students feel more challenged and motivated to study more independently and discuss with friends, increase self-confidence and improve creative and critical thinking skills ((Saiful et al., 2019).

This is in line with the observation that in the jumping task students need a longer time due to the increasing difficulty level of the problem while in the sharing task students need a shorter time so that it can be said that the discussion process is also a little, but the sharing task is able to make students get used to sharing their opinions before increasing to the next stage. In line with the research of Wijaya et al. (2024) where the stage of students doing collaboration are when students investigate problems in groups, find evidence and present findings and evaluate what they get themselves as answers.

At the end of learning, students also wrote that the questions on the student worksheet were quite difficult but because they were done in groups, the questions were easier. According to Dewi et al (2024) listening to other people's ideas is an important factor in collaboration, because from the opinions of others, we will get a new understanding that is different from ours so that this aspect can enchance the course of activities Students are also happy during group learning because they can more easily discuss, especially when there are questions that are difficult to understand if done alone. Difficult questions do not mean that they will destroy students' abilities, but with good management, difficult or challenging questions will stimulate dialogue, interaction and collaboration between students. So that learning activities are more meaningful (Nofrion, 2017).

It took good cooperation and collaboration to achieve common goals so they will finish the product within given timeframe (Kurniahtunnisa et al., 2023). In this case working time management is also faster because students work on problems together so that students do not have the habit of postponing tasks because they work with peers. So as stated by Suharti et al. (2019) from the use of this student worksheet, there is a positive dependence between students. When associated with improved competencies in science literacy and collaborative skills, Effective time management has a big impact on a student's performance in a classroom. Students can increase their productivity, lower their stress levels, and improve their overall academic success by effectively managing and using their time (Dalia & Putra, 2023). Through time management students will get their goal that related the way in using their time (Roza & Yulmiati, 2023). So the initial problem which student where students always submit the worksheets at different times can be resolved along with the enhanced ability of science literacy and collaboration skills.

Conclusion

This study aims to develop IBSC based student worksheet to improve student's science literacy and collaboration skills. Based on the results of the research, development, and analysis as well as the discussion that has been carried out, it can be concluded that IBSC based student worksheet has met the eligibility criteria which can be seen in the expert assessment. The results of the validation given by the media expert stated the value was in the good category, means that IBSC based student worksheet is valid for use. From teachers and students assessment about the product, it can be concluded that IBSC based student worksheet considered practical based on the value which is in the good category and based on results of teacher observations regarding the implementation of the use of products and instruments. Then, the effectiveness is obtained from the Manova test with a value of 0.000 so it can be concluded that the product is effective in improving both variables. This is also supported by the N-Gain value which gets a fairly effective category with an average value of 60.57 and 62.58. In conclusion, the results of the research show that

IBSC based LKPD on human respiratory system material is suitable and practical to use in learning and more effective for improving students' science literacy and collaboration skills

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Principal investigator and author of the article, P.P.B.; collecting data, P.P.B.; create product, instruments test,P.P.B; make product validation assessments, P.P.B; make an evaluation, P.P.B; Developing and testing research products, P.P.B.; data processing and author of draft articles, P.P.B; Researcher and author of both articles, P.P.B; validate the instrument and validate the the product, K.R.P.; supervisor who guided and directed the first author, K.R.P.

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References

Agustian, N. Z., & Setiawan, A. M. (2024). The Development of Hologram Media on the Motion of Object in Physics to Improve Students Learning Outcomes in Junior High School. *Jurnal Penelitian Pendidikan IPA*, *10*(6), 3404–3413. https://doi.org/10.29303/jppipa.v10i6.5853

Alaloul, W. S., Musarat, M. A., Liew, M. S., Qureshi, A. H., & Maqsoom, A. (2021). Investigating the impact of inflation on labour wages in Construction Industry of Malaysia. *Ain Shams Engineering Journal*, *12*(4), 1575–1582. https://doi.org/10.1016/j.asej.2020.08.036

Amin, D. I., Sutrisno, & Sigit, D. (2018). Instrumen Asesmen Pemahaman Konseptual Berorientasi Higher Order Thinking Skills Keterampilan Proses dan Sikap terhadap Sains pada Bahan Kajian Hidrokarbon dan Minyak Bumi. *Jurnal Pendidikan: Teori, Penelitian Dan Pengembangan*, *3*(9), 1142–1146. https://doi.org/10.17977/jptpp.v3i9.13342

Asari, S. (2017). Sharing And Jumping Task In Collaborative Teaching And Learning Process. *Didaktik*, *23*(2), 184–188. https://doi.org/10.30587/didaktika.v23i2.28

Azar, A. S., Keat, O. B., & Arutus, J. S. (2021). Collaborative Learning in The Classroom: The Study of Malaysian University Student' Attitude. *Ilkogretim Online- Elementary Education Online*, *20*(4), 272–284 10 17051 2021 04 30. https://doi.org/10.17051/ilkonline.2021.04.30

Boury, N., Alvarez, K. S., Costas, A. G., Knapp, G. S., & Seipelt-Thiemann, R. L. (2021). Teaching in The Time of COVID-19: Creation of a Digital Internship to Develop Scientific Thinking Skills and Create Science Literacy Exercises for Use in Remote Classrooms. *Journal of Microbiology and Biology Education*, *22*(1), 1–7. https://doi.org/10.1128/jmbe.v22i1.2433

Brannen, S. F., Beauchamp, D., Cartwright, N. M., Liddle, D. M., & Tishinsky, J. M. (2021). Effectiveness of group work contracts to facilitate collaborative group learning and reduce anxiety in traditional face-to-face lecture and online distance education course formats. *International Journal for the Scholarship of Teaching & Learning*, *15*(2), 1–12. https://doi.org/10.20429/ijsotl.2021.150205

Chang-Tik, C., Tee, M. Y., & Kidman, G. (2022). *Collaborative Active Learning: Practical Activity-Based Approaches to Learning - Assessment and Feedback*. Palgrave Macmillan. https://doi.org/10.1007/978-981-19-4383-6

Croce, K. A., & Firestone, J. B. (2020). *Developing Science Literacy in the 21st Century*. Information Age Publishing Inc.

Dalia, A. C., & Putra, F. R. (2023). Having Effective Time Management Give Influence Students Academic Achievement. *Journal of Educational Learning and Innovation (ELIa)*, *3*(2), 403–413. https://doi.org/10.46229/elia.v3i2.739

Dewi, S. S., Aznam, N., & Amaliyah, N. I. (2024). Senior High School Students' Collaborative Skills through Acid-Base Chemistry Practicum Activities. *Jurnal Penelitian Pendidikan IPA*, *10*(4), 1869–1877. https://doi.org/10.29303/jppipa.v10i4.5081

Ekeh, M. C. (2023). Developing Early Graders' Collaborative Skills through Group-Work, Play-Based Pedagogy. *International Journal of Learning-Teaching and Educational Research*, *22*(4), 160–177. https://doi.org/10.26803/ijlter.22.4.10

Fajariningtyas, D. A., Hidayat, J. N., & Anekawati, A. (2021). Pengembangan Lembar Kerja Mahasiswa Berorientasi Pemecahan Masalah Pada Keterampilan Komunikasi dan Kolaborasi. *Eksakta: Jurnal Penelitian Dan Pembelajaran MIPA*, *6*(2), 215–221. https://doi.org/10.31604/eksakta.v6i2.215-221

Fakhrudin, N., & Suharti, P. (2021). Pengembangan Perangkat Pembelajaran Model Investigation Based Scientific Collaborative (IBSC) untuk Melatihkan Kemampuan Berfikir Kritis Dan Ketrampilan Komunikasi Siswa. *Jurnal Pedago Biologi*, *12*(2), 40–47. Retrieved from https://journal.um-surabaya.ac.id/Biologi/article/view/9340

Feng, Q., Luo, H., Li, W., Chen, T., & Song, N. (2023). Effects of Gender Diversity on College Students' Collaborative Learning: From Individual Gender to Gender Pairing. *Heliyon*, *9*(6). https://doi.org/10.1016/j.heliyon.2023.e16237

Gormally, C., P., B., & Lutz, M. (2012). Developing a Test of Scientific Literacy Skills (TOSLS): Measuring Undergraduates' Evaluation of Scientific Information and Arguments. *Life Science Education*, *11*, 364–377. https://doi.org/10.1187/cbe.12-03-0026.

Gustiani, S. (2019). Research and development (R&D) method as a model design in educational research and its alternatives. *Holistics (Hospitality and Linguistics): Jurnal Ilmiah Bahasa Inggris*, *11*(2). Retrieved from https://jurnal.polsri.ac.id/index.php/holistic/article/view/1849

Hahs-Vaughn, D. (2016). *Applied Multivariate Statistikal Concepts*. England. Taylor & Francis. https://doi.org/10.4324/9781315816685

Hartono, H., Indra Putri, R. I., Inderawati, R., & Ariska, M. (2022). The strategy of Science Learning in Curriculum 2013 to Increase the Value of Science's Program for International Student Assessment (PISA. *Jurnal Penelitian Pendidikan IPA*, *8*(1), 79–85. https://doi.org/10.29303/jppipa.v8i1.1185

He, S., Shi, X., Choi, T. H., & Zhai, J. (2023). How do students'roles in collaborative learning affect collaborative problem-solving competency? A systematic review of research. *Thinking Skills and Creativity*, *50*, 101423. https://doi.org/10.1016/j.tsc.2023.101423

Herayanti, L., Habibi, H., & Sukroyanti, B. A. (2022). Development of Inquiry-Based Teaching Materials to Improve Physics Teacher's Conseptual Understanding. *Jurnal Penelitian Pendidikan IPA*, *8*(6), 3110–3116. https://doi.org/10.29303/jppipa.v8i6.2543

Hobri, A., S., M., P., R., Oktavianingtyas, E., & Putri, I. W. S. (2021). Students' Critical Thinking Process in Solving Jumping Task According to Gregorc's Thinking Style. *Jurnal Didaktik Matematika*, *8*(1), 15–31. https://doi.org/10.24815/jdm.v8i1.19776

Husna, N., Halim, A., Evendi, E., Syukri, M., Nur, S., Elisa, E., & Khaldun, I. (2022). Impact of Science Process Skills on Scientific Literacy. *Jurnal Penelitian Pendidikan IPA*, *8*(4), 1827–1833. https://doi.org/10.29303/jppipa.v8i4.1887

Johnson, R. A., & Wichern, D. W. (2007). *Applied Multivariate Statistikal Analysis (6ed)*. Pearson Prentice Hall.

Junita, W., & W, K. (2020). Efektivitas Model Pembelajaran STAD dan CIRC terhadap Peningkatan Keterampilan Kolaborasi Siswa Kelas V SD Gugus Joko Tingkir pada Mata Pelajaran Tematik. *Jurnal Pendidikan Dasar Indonesia*, *5*(1), 11–17. https://doi.org/10.26737/jpdi.v5i1.1688

Kaleka, M., & Nur, F. D. M. (2018). Experimental-Based Scientific Approach toward the improvement of Science Process Skill and Scientific Attitudes of Grade X Student MAN Ende. *Journal of Science Education Research*, *2*(1), 13–20. https://doi.org/10.21831/jser.v2i1.19328

Klemencic, E., Virtic, M. P., & Kovacic, J. M. (2023). The Role of Teacher Education in The Science Literacy Development. *Athens Journal of Education*, *10*(4), 647–668. https://doi.org/10.30958/aje.10-4-5

Kristiyanti, M. (2010). Internet Sebagai Media Pembelajaran Yang Efektif. *Majalah Ilmiah Informatika*, *1*(1), 8–29. Retrieved from https://unaki.ac.id/ejournal/index.php/majalah-ilmiah-informatika/article/view/3

Kurniahtunnisa, A., Y.U., R., S., & Harahap, F. (2023). STEM-PjBL Learning: The Impacts on Students' Critical Thinking, Creative Thinking, Communication, and Collaboration Skills. *Jurnal Penelitian Pendidikan IPA*, *1*(1). https://doi.org/10.29303/jjppipa.v1i1.264

Laal, M. (2012). Collaborative learning; What is it. *Procedia-Social and Behaviorial Sciences*, *31*, 491–495. https://doi.org/10.1016/j.sbspro.2011.12.092

Lelasari, M., Setyosari, P., & Ulfa, S. (2017). Pemanfaatan Social Learning Network dalam Mendukung Keterampilan Kolaborasi Siswa. *Seminar Nasional Teknologi Pembelajaran Dan Pendidikan Dasar 2017*, 167–172. Retrieved from https://shorturl.asia/MHZ4k

Lu, H. S., & Smiles, R. (2022). The Role of Collaborative Learning in the Online Education. *International Journal of Economics, Business and Management Research*, *6*(6), 97–106. https://doi.org/10.51505/ijebmr.2022.6608

Lutfiah, I., Suharti, P., & Asy'ari. (2021). Improving Students' Creative Thinking Skills through the IBSC (Investigation Based Scientific Collaborative) Learning Model Based on E-Learning. *Science Education Journal*, *5*(2), 85–97. https://doi.org/10.21070/sej.v5i2.1572

Lutvita, D., Pambudi, D. S., Lestari, C. F., & Wahyuningrum, F. Y. (2020). Student's Higher Order Thinking Skills on Problem Solving Based on Jumping Tasks. *Journal of Physics: Conference Series*, *1538*, 1–18. https://doi.org/10.1088/1742-6596/1538/1/012076

Melawati, O., Evendi, E., Halim, A., Yusrizal, Y., & Elisa, E. (2022). Influence of the Use of Student Worksheet Problem-Based to Increase Problem

Solving Skills and Learning Outcomes. *Jurnal Penelitian Pendidikan IPA*, *8*(1), 346–355. https://doi.org/10.29303/jppipa.v8i1.1205

Murtikusuma, R. P., Hobri, H., & Pratiwi, C. C. (2022). Analysis of Student Error in Completing Sharing task and Jumping Task based On Watson Criteria. *Edumatica : Jurnal Pendidikan Matematika*, *12*(02), 150–159. https://doi.org/10.22437/edumatica.v12i02.17032

Nofrion. (2017). Peningkatan Aktivitas Belajar Siswa Melalui Penerapan Metode "Jumping Task ada Pembelajaran Geografi. *P Jurnal Geografi*, *9*(1), 11–20. https://doi.org/10.24114/jg.v9i1.6043

Nuha, U., Scisnayani, Y., Supeno, W., D., & Rusdianto. (2023). Development of Collaborative-Based Worksheets to Improve Science Process Skills in Science Learning. *Jurnal Penelitian Pendidikan IPA*, *9*(7), 5390–5397. https://doi.org/10.29303/jppipa.v9i7.2927

Prasetyo, D., Marianti, A., & Alimah, S. (2021). Improvement of Students' science literacy skills using STEM-Based E-Modules. *Journal of Innovative Science Education*, *10*(37), 216–221. https://doi.org/10.15294/JISE.V9I3.43539

Pratita, D., Barlian, I., & Rivai, R. A. (2018). Development of Student Worksheet on Materials Economy Based Problem Solving. *Humaniora*, *9*(2), 211–220. https://doi.org/10.21512/humaniora.v9i2.4562

Purnomo, S. (2022). *Analisis Data Multivariat*. Banyumas: Omera Pustaka.

Putri, I. B. K., & Wulandari, F. (2022). Scientific Literacy Skill Through Digital Media Professional Pdf Flip Based Book in Elementary School. *Jurnal Penelitian Pendidikan IPA*, *8*(5), 2266–2271. https://doi.org/10.29303/jppipa.v8i5.218

Rahmania, S., Miarsyah, M., & Sartono, N. (2015). Perbedaan Kemampuan Literasi Sains Siswa dengan Gaya Cognitive Field Independent dan Field Dependent. *Biosfer Jurnal Pendidikan Biologi*, *8*(2), 27–34. https://doi.org/10.21009/biosferjpb.8-2.5

Roza, M., & Yulmiati, A. R. (2023). The Correlation Between Students' Time Management And Their English Learning Achievement At Voscational School. *Jurnal Pendidikan Mandala*, *8*(3), 860–866. https://doi.org/10.58258/jupe.v8i3.5899

Saiful, S., Susanto, S., & Hobri, H. (2019). The Students' Metacognition Analysis Through Jumping Task Based on Lesson Study for Learning Community. *Journal of Physics: Conf. Series*, *1265*. https://doi.org/10.1088/1742-6596/1265/1/012002

Saputri, D. A., Masykuri, M., & Utomo, S. B. (2022). Development of Reasoning Multiple Choice Questions (RMCQs) to Analyze Higher Order Thinking Skills. *Educhemia : Jurnal Kimia Dan Pendidikan*, *7*(1), 76–86. https://doi.org/10.30870/educhemia.v7i1.11791.g10247

Stockemer, D. (2018). Quantitative Methods for Social Sciences: A Practical. In *Introduction with Examples in SPSS and Stata*. Springer. https://doi.org/10.1007/978-3-319-99118-4

Subali, B. (2010). *Penilaian, Evaluasi, dan Remediasi Pembelajaran Biologi*. Yogyakarta: Universitas Negeri Yogyakarta.

Sucipto, S., Setiawan, W., & A, H. (2024). The effectiveness of collaborative learning on civic education problem-solving abilities based on cognitive styles. *Research and Development in Education (RaDEn)*, *4*(1), 149–161. https://doi.org/10.22219/raden.v4i1.32253

Suharti, P., Ibrahim, M., & Rahayu, Y. S. (2019). Validity of Investigation Based Scientific Collaborative (IBSC) Learning Model To Facilitate Students' Communication and Collaboration Skills. *Advances in Social Science, Education and Humanities Research*, *390*, 172–176. https://doi.org/10.2991/icracos-19.2020.37

Supriyadi, S., Nelly, A., Ika, W. U., & Amrina, I. (2021). The Use of Student Worksheets Based on a Science Approach in Internalizing the Attitudes and Character of Elementary School Students. *International Journal of Multicultural and Multireligious Understanding*, *8*(2), 152–161. https://doi.org/10.18415/ijmmu.v8i2.2323

Tai, C. C., Moran, R. M., Robertson, L., Keith, K., & Hong, H. (2020). *Handbook of Research on Science Literacy Integration in Classroom Environments*. IGI Global.

Trapsilasiwi, D., Jatmiko, D. D. H., Pambudi, D. S., Ambarwati, R., & Alim, F. (2023). An Analysis of Students'Critical Thinking Ability in Solving Jumping Task Questions based on Learning Style. *JIML*, *6*(4), 319–327. https://doi.org/10.22460/jiml.v6i4.p21727

Virtic, M. P. (2022). Teaching Science & Technology: Components of Scientific Literacy and Insight into the Steps of Research. *International Journal of Science Education*. https://doi.org/10.1080/09500693.2022.2105414

Walston, S. L., & Johnson, K. L. (2022). *Organizational Behavior and Theory in Healthcare*. Chicago: Health Administration Press.

Wijaya, T. P., Mundilarto, & Wilujeng, I. (2024). Development of Problem Based Learning Collaborative (PBL-C) Physics E-Worksheet to

Improve Student Problem Solving and Collaboration Skills. *Jurnal Penelitian Pendidikan IPA*, *10*(1), 47–54. https://doi.org/10.29303/jppipa.v10i1.5284

Yuliati, Y. (2017). Literasi sains dalam pembelajaran IPA. *Jurnal Cakrawala Pendas*, *3*(2). https://doi.org/10.31949/jcp.v3i2.592

Yulkifli, N., M.V., I., & W. (2019). The Validity of Student Worksheet Using Inquiry-Based Learning Model with Science Process Skill Approach for Physics Learning of High School. *Jurnal Penelitian Dan Pengembangan Pendidikan Fisika*, *5*(2), 155–162. https://doi.org/10.21009/1.05210

Zestia, W. S., & Nahadi, A. (2022). Implementation of Sharing & Jumping Tasks Learning to Grow Students' Creative Thinking Skills in Buffer Solution. *Journal of Educational Science*, *6*(1), 11–23. https://doi.org/10.31258/jes.6.1.p.11-23

Zubaidah, S. (2016). Keterampilan abad ke-21: Keterampilan yang diajarkan melalui pembelajaran. *Seminar Nasional Pendidikan*, *2*(2), 1–17. Retrieved from https://shorturl.asia/XlshP