Relationship between knowledge and reproductive health attitudes with early marriage at gowa regency high school

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Article Info	ABSTRACT
	This research is important to carry out to provide information, knowledge, and understanding regarding adolescent reproductive health topics. This study aims to determine the relationship between knowledge and attitudes about reproductive health and early marriage among teenagers in Gowa Regency High School. The population of this study was all class XI at SMA Gowa Regency. The sampling technique was carried out using the simple random sampling technique. This type of research is descriptive correlational research which aims to determine whether there is a relationship between variables. This research design uses a cross-sectional study design. The research instruments used were tests and questionnaires, data collection techniques in multiple-choice questions to measure reproductive health knowledge, and a questionnaire that refers to Likert scale parameters to measure attitudes towards reproductive health and early marriage. This research data analysis technique uses descriptive and inferential data analysis techniques. There is a relationship between knowledge and Reproductive health attitudes and early marriage are significant with a correlation value (R) between variables was 0.789 which is included in the strong correlation category.

INTRODUCTION

Adolescence is a transition period between childhood and adulthood, even teenagers at this stage have not yet reached mental and sexual maturity. During this period, situations occur that illustrate confusion regarding clear placement where teenagers are neither children nor adults, resulting in various changes that occur. significant, both biologically, mentally, emotionally, and psycho-socially. (Esty et al, 2019). Teenagers will experience rapid physical changes when they

enter puberty. One of these physical changes is the ability to carry out the reproductive process, but many phenomena show that some teenagers do not know and understand reproductive health, for example, menstruation and pregnancy (Ernawati, 2018). Cases surrounding adolescent reproduction are now increasing, due to adolescents' lack of understanding of various aspects of reproduction related to themselves. Improving the quality of adolescent reproductive health can be done by paying attention to health communication problems. Problems that occur in adolescent reproductive health can include sex before marriage, dropping out of school due to pregnancy, irresponsible partners, use of contraceptives, abortion, HIV/AIDS infection, and infectious diseases. sexual activity and the use of illegal drugs which is caused by teenagers' low knowledge about sexuality (Liang et al, 2019).

The reason why teenagers' knowledge about reproductive health is still low is because Firstly, teenagers do not know who to ask and where about reproductive health. Secondly, access to good and correct information about reproductive health is very limited (the role of teachers, parents, peers and the media mass), Third, effective parent-adolescent communication about reproductive health is still considered taboo. Fourth, reproductive health information is not studied in schools as part of the curriculum. Fifth, parents have limited knowledge about reproductive health and sixth, the influence of socio-cultural and religious norms in society does not support teenagers in accessing reproductive health information. Lastly, various information in the media is misleading, causing teenagers' sexual lives to be unhealthy and irresponsible (Intizar & Hamdi, 2021).

Reproductive health is an important element in general health, for both women and men. Reproductive health can also affect the health of babies, children, teenagers, and people beyond the reproductive age (menopause). Understanding the influence of reproductive health on health is not yet widely understood. This is caused by a lack of correct information regarding reproductive health. This lack of information not only occurs among teenagers but also among adults and the elderly. Usually lay people interpret reproductive health only as things related to the reproductive organs (Emilia Ova et al, 2019). Reproductive health as described above covers many aspects of life. Public ignorance regarding reproductive health issues gives rise to new problems caused by unsafe behavior, for example, the emergence of diseases related to reproduction.

There are 4 factors that influence reproductive health, namely socio-economic factors starting from poverty, ignorance about sexual and reproductive development, low education, cultural and environmental factors including beliefs about having many children, lots of luck, and traditional practices that hurt reproductive health. , Biological factors include defects suffered from birth and reproductive defects due to infectious diseases (Permatasari Dian & Suprayitno, 2021). Another influencing factor is psychological factors which include the impact of parental rift on teenagers, depression due to hormonal imbalance, women feeling worthless in men who buy their freedom in material form (Ariyanti et al., 2019). Norms in the family can also be a strong contributor in the socialization of adolescents in terms of sexual behavior, while parents bear the responsibility for providing information and education as well as support that may be needed, especially in the physical and emotional changes during adolescent puberty (Usonwu et al, 2021).

Reproductive health is the end result of a state of physical, mental and social health and freedom in all matters relating to the reproductive system, function and process. Adolescents have the value of hope and the value of ability. If there is an imbalance between these two values, it will cause negative impacts such as frustration which stimulates the younger generation to carry out deviant actions such as problems related to unprotected sexuality, the spread of venereal disease, and even unwanted pregnancies. undesirable among teenagers (Marmi, 2013).

Adolescent reproductive problems apart from having a physical impact, can also affect mental and emotional health, economic conditions, and social welfare in the long term. These long-term impacts not only affect the teenagers themselves, but also the family, society, and nation in the

end. The high rate of pregnancy and abortion among teenage girls is caused by ignorance and unawareness regarding fertile conditions. There are many myths and mistaken assumptions among teenagers that pregnancy will not occur the first time they have sex (Hasanah Hasyim, 2016).

Adolescents have the right to gain knowledge and understanding about pregnancy so that they have responsibility for the situation and conditions they are experiencing. Adolescents also understand their fertility status, so they do not engage in sex outside marriage or casual sex. There are many causes of teenage pregnancy, including peer pressure, proving masculinity, feelings of fear and shame regarding sexual information, involvement in the information media, and an increasingly globalized societal culture. In cases of unwanted pregnancy, it often ends in abortion and the death of both the mother and fetus (Fathkiyah et al, 2020). People with understanding certainly direct themselves not to carry out factors that cause risks and negative impacts on themselves. On the other hand, teenagers who have low understanding tend to lack concern and awareness in protecting and caring for their reproductive organs, which then often ends in sexual violence against teenagers.

Adolescent Reproductive Health (KRR) is an integrated part of health and family planning programs in Indonesia. This integrated program specifically aims to address problems related to early marriage, unwanted pregnancies, tobacco and alcohol consumption, and HIV-AIDS. Most teenagers aged 15-19 years have been exposed to educational institutions for quite a long period schools are institutions that have the potential to provide KRR education (Ministry of Health, 2013).

Early marriage experienced by teenagers under 20 years old is still a phenomenon in several regions of Indonesia, especially in remote areas where there is a lack of access to education. At the beginning of 2023, Indonesia itself was recorded as one of the countries with the most cases of early marriage, namely in 8th place in the world. The highest case of early marriage in Indonesia is Sulawesi which is in 3rd place after Java and Sumatra (United Nations Children's Fund, 2019). During the COVID-19 pandemic, there was a spike in cases of early marriage in several provinces in Indonesia, one of which had the highest spike in cases of early marriage was West Java. In line with this, UNFPA predicts that early marriage will increase by 13 million cases globally in the next 10 years due to the potential for a difficult economic situation which causes many parents to marry off their children to escape their economic burden (Rumiatun et al., 2020).

In early marriages involving teenage girls, there are great risks in terms of health, such as high rates of maternal morbidity and mortality due to complications in pregnancy and childbirth, eclampsia, anemia and cervical cancer, premature birth, children born with low birth weight, mortality, and morbidity as well. higher for children born to young mothers (Fransiska & Sastono, 2020).

Pregnancy at a very young age can increase health risks for women and their babies. This is because the body is not ready to become pregnant and give birth. Pregnancy at an age that is too young has high risks such as increased blood pressure, anemia, premature babies who generally have low birth weight (LBW) because they are not ready to be born (at less than 37 weeks of pregnancy) even women Under the age of 18 who are pregnant and give birth are at risk of dying during childbirth. The reason is, at this young age their bodies are not yet mature and physically ready to give birth (Hermambang et al., 2018).

RESEARCH METHODS
Research Design

This type of research is by the research objective, namely to determine the relationship between knowledge and attitudes about reproductive health and early marriage in Gowa Regency High Schools. The research population was class XI high school students in Gowa Regency with

an average age of 15-17 years. Sampling in this study was carried out using simple random sampling. Data collection instruments were carried out by distributing multiple-choice tests regarding reproductive health knowledge and questionnaires for reproductive health attitudes and attitudes towards early marriage. The data obtained were analyzed using descriptive and inferential data analysis techniques to determine the level of reproductive health knowledge and attitudes towards early marriage using the SPSS 24.0 application.

To categorize students' knowledge of reproductive health, it refers to literature written by Arikunto (2016) regarding research procedures for a practical approach, while the Likert scale category in measuring teenagers' attitudes towards reproductive health and early marriage, refers to literature written by Sugiyono (2017) about quantitative and qualitative research methods.

Population and Samples

The population of this research is all class XI at SMA Gowa Regency, Meanwhile, the sampling technique used simple random sampling, the reason is that this technique is an easy and quite simple sampling method and has high external validity because it represents the characteristics of a larger population and from the results of sampling, 260 samples were obtained.

Instruments

The instrument used in this research is multiple choice questions totaling 25 questions to measure knowledge of reproductive health where the indicators include the structure and function of reproduction in humans, mechanisms of reproductive organs, abnormalities in the reproductive system, LGBT, and sexual behavior while the questionnaire on reproductive health variables and questionnaires In the early marriage variable, there are 25 statements each, where the indicators in the reproductive health variable include indicators of menstruation, puberty, fertility, pregnancy, sexual drive, sexually transmitted diseases, and indicators in early marriage, namely there are indicators of education, economic status, culture, relationships. freedom, mass media, religious beliefs, and parental discipline. All instruments used have been tested for their suitability through validation by two expert validators and each validation result from the validator provides a good average validity value, in other words, they are suitable for use as research instruments.

Procedures

In conducting research there are several steps, namely the first is preparation. This stage is the initial stage carried out by researchers before going out into the field to conduct research, namely making proposals, providing guidance, proposal seminars, making research instruments, and validating research instruments by validators. After that, it continues with the research implementation stage, namely the research is carried out by giving tests and questionnaires to students for data collection. Researchers analyzed student's answers regarding the suitability of the data with indicators of students' knowledge regarding reproductive health and attitudes towards early marriage, then the final stage was the stage where the data obtained after conducting research in the field was analyzed using descriptive statistics and inferential statistics to determine the relationship between knowledge and Reproductive health attitudes towards early marriage among teenagers in Gowa Regency High School. This research implies that information is obtained about reproductive health knowledge and attitudes from teenagers. What is meant by teenagers here are students so that they can provide information to future researchers. The procedures carried out in this research can be described in the form of a flow diagram as Figure 1.
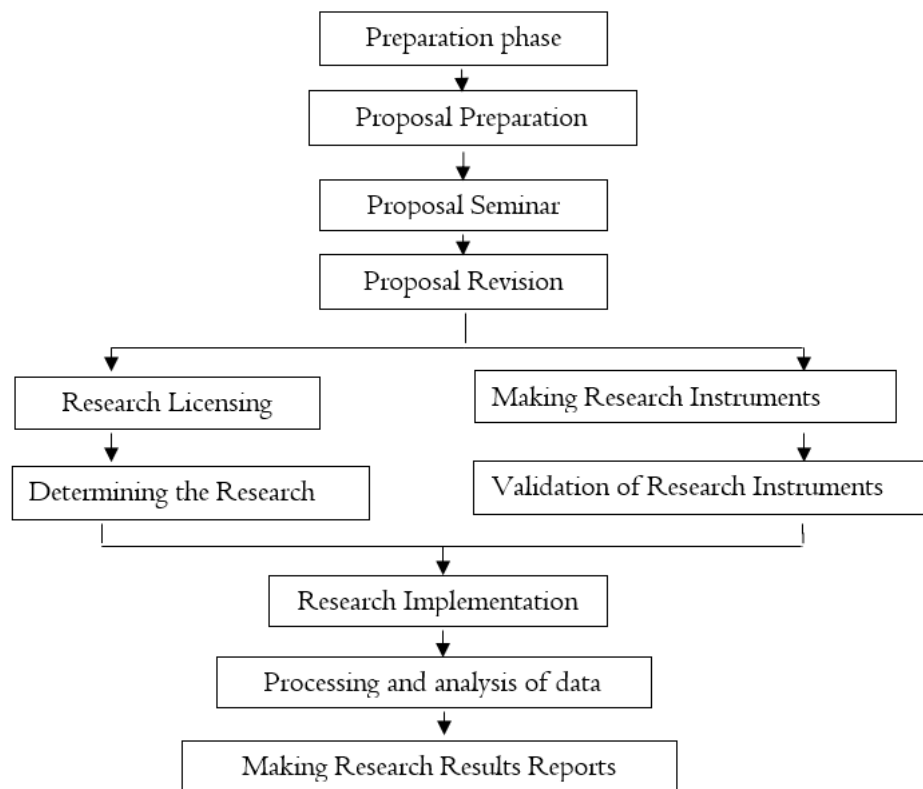
Figure 1. Research Procedures.

Data Analysis

The data analysis technique in this research uses descriptive data analysis techniques and inferential data analysis techniques. Descriptive analysis techniques were carried out to determine the frequency distribution and percentage of each variable, both dependent and independent variables. Meanwhile, inferential data analysis techniques are carried out in several stages, namely the normality test, linearity test, then hypothesis test. The types of hypothesis testing used are descriptive hypothesis testing and also inferential hypothesis testing

RESULTS

a. Reproductive Health Knowledge of High School Adolescents in Gowa Regency

The results of the descriptive analysis of the reproductive health knowledge variable of The results of the descriptive analysis of the reproductive health knowledge variable of high school adolescents in Gowa Regency obtained the lowest (minimum) value of 40.00; The highest (maximum) value is 92.00 and the average (mean) value is 61.69 standard mean deviation. From the research results, the categorization of Reproductive Health knowledge values of high school students in Gowa Regency is obtained as shown in Table 1.

Table. 1. Categorization of the Value of Reproductive Health Knowledge

Interval	Category	Frequency	Persentase
81 – 100	Very Good	12	4,6
61 – 80	Good	144	55,4
41 – 60	Enough	102	39,2
21 – 40	Less	2	0,8
≤ 20	Very Less	0	0
Total		260	100%

Based on Table 1. the value of reproductive health knowledge shows that 36 people (13.8%) are in the good category, 100 people (38.4%) are in the sufficient category, and 124 people (47.6%) are in the poor category. If seen from the highest frequency and also the average value obtained, it can be categorized that the reproductive health knowledge of high school teenagers in Gowa Regency is in the poor category.

b. Reproductive Health Attitudes of High School Adolescents in Gowa Regency

The results of the descriptive analysis of the reproductive health attitude variable obtained the lowest (minimum) value of 61.00, the highest (maximum) value was 90.00, and the average (mean) value of 81.47 standard mean deviations. From the research results, a categorization of the reproductive health attitude values of high school students in Gowa Regency was obtained as shown in Table 2.

Table. 2 Categorization of Reproductive Health Attitudes

Interval	Category	Frequency	Persentase
81,3-100	Very Good	146	56,2
62,5-81,3	Good	113	43,5
43,8-62,5	Enough	1	0,4
25-43,8	Not Enough	0	0
Total		260	100%

Based on the data in Table 2 above, there are 4 categories of reproductive health attitudes of high school teenagers in Gowa Regency, namely the very good category with 146 people (56.2%), the Good category with 113 people (43.5%), the fair category with 1 person (0.4%), and none of them were in the bad category.

c. Attitudes to Early Marriage among High School Adolescents in Gowa Regency

The results of descriptive analysis of the variable Attitudes towards the early marriage of high school teenagers in Gowa Regency obtained a minimum value of 58.00; The maximum value is 95.00 and the average value is 81.73 standard mean deviation. From the research results, a categorization of early marriage attitude values for high school students in Gowa Regency was obtained as shown in Table 3.

Table 3. Categorization of early marriage attitude values

Interval	Categori	Frequency	Persentase
81,3-100	Very Good	139	53,4
62,5-81,3	Good	117	45
43,8-62,5	Enough	4	1,5
25-43,8	Not Enough	0	0
Total		260	100%

Based on the data in Table 3 above, there are 4 categories of attitudes toward early marriage among high school teenagers in Gowa Regency, namely the very good category with 139 people (53.4%), the good category with 117 people (45%), the fair category with 4 people (1.5%), and none of them are in the bad category.

d. The relationship between knowledge and attitudes about reproductive health and early marriage among teenagers in high schools in Gowa Regency

To see the relationship between the variables of reproductive health knowledge and reproductive health attitudes and early marriage attitudes, the F-test formula or multiple correlation test was used together, and then compared the correlation coefficient and determination coefficient values to see the closeness of the relationship using the SPSS 26 for Windows application with the results. can be seen in Table 4.

Table 4 Multiple Correlation F-Test Results between Variables X1 and X2 on Variable Y

ANOVA[a]					
Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	148.628	2	1156.47	13.311	.000[b]
Residual	8426.06	257	86.88		
Total	8574.68	259			

a. Dependent Variable: Attitude to early marriage (Y)
b. Predictors: (Constant), Reproductive health knowledge (X1), reproductive health attitudes (X2)

Based on Table 4 above, the significance value of the F test results between the reproductive health knowledge variable (X1) and the reproductive health attitude variable (X2) with the early marriage attitude variable (Y) is 0.000 < 0.05 and the Fcount value is 13.311 > Ftable 3.030, indicating that There is a relationship between knowledge and attitudes about reproductive health and early marriage among teenagers in Gowa Regency High School, so that based on decision making references, Ha is accepted and H0 is rejected. The close relationship and contribution of variables X1 and X2 to variable Y can be seen through the SPSS model summary output in Table 5.

Table 5. Correlation and Determination Coefficient between Variables X1 and X2 on Variable Y

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.497[a]	.247	.229	5.726

a. Predictors: (Constant), Reproductive health knowledge (X1), Reproductive health attitudes (X2)

Table 5 above shows the correlation or relationship value (R) between the variables reproductive health knowledge (X1) reproductive health attitudes (X2) and early marriage attitudes (Y), namely 0.497 which is in the interval 0.40-0.599 so it is in the category " currently". The coefficient of determination (R2) as the contribution value of variables X1 and X2 to variable Y is 0.247. The R2 value shows the contribution of reproductive health knowledge and reproductive health attitudes to attitudes towards early marriage of 0.247 or 24.7%, while the remaining 75.3% is the contribution of several other factors which also play a role in influencing attitudes towards early marriage among teenagers in Gowa Regency High School.

DISCUSSION

a. Knowledge of Adolescent Reproductive Health in Senior High Schools in Gowa Regency

Knowledge is information that a person knows and is aware of, knowledge is a phenomenon that humans encounter and obtain through mental observation or sensing. Knowledge is closely

related to a person's level of health. The higher a person's knowledge, the easier it is for them to accept the concept of healthy living independently. If a teenager's knowledge level is good, their health level will also be good (Suharti & Surmiasih, 2016). Knowledge can also influence a person's attitude. A person with good knowledge about reproductive health tends to have good attitudes or behavior regarding reproductive health and various types of casual sex (Sahertian Betty, 2017).

In general, someone enters adolescence without adequate knowledge about reproductive health, so most teenagers fall into deeper and deeper ignorance. Not only that, parents also have a big influence on a child's knowledge, parents who have good education regarding reproductive health will definitely provide good sources of information regarding reproductive health and provide education about various kinds of dangers regarding the impact of health. reproduction itself.

Based on the research results, the frequency obtained from the educational characteristics of the respondents' parents was that 18 people had completed elementary school (6.9%), 46 people had completed junior high school (17.7%), 155 people had completed high school (59.6%), had completed S1 as many as 35 people (13.5%), 6 people (2.3%) did not finish school, for father's education and for mother's education, namely 24 people finished elementary school (9.2%), 44 people graduated from junior high school (16, 9 %), 147 people (57.6 %), 36 people (14.5 %) finished high school, 9 people (3.4 %) did not finish school.

From the frequency of parental education characteristics of the respondents, it can be seen that the average parent's education is in the high school graduate category, some even have not finished school, so it can be concluded that one of the factors in teenagers' lack of knowledge regarding reproductive health comes from low education. parents, because parents who have higher education will also provide good knowledge to their children, provide education and lessons that they do not get from the learning curriculum at school.

Most teenagers think that parents have an important role for them because the values instilled by parents can influence teenagers' knowledge. They think that if parents can provide an understanding of reproductive health knowledge to their children, then these children tend to control their sexual behavior which can affect the reproductive organs, this happens because basically the best sex education is given by the parents themselves and can also be realized through the lifestyle of the parents in a family (Bulahari et al, 2015).

b. Adolescent Reproductive Health Attitudes in High Schools in Gowa Regency

Attitude is an individual's tendency to act, in the form of a closed response to certain stimuli or objects. Attitude is not yet an action or activity but is a predisposition to a behavior. Attitude is a readiness to react to objects in a certain environment as an appreciation of something, behavior can be influenced by knowledge and attitudes which are able to show shifts in values and norms (Sirupa et al, 2016).

The results of descriptive analysis on the reproductive health attitude variable obtained were the lowest (minimum) value of 61.00, the highest (maximum) value of 90.00, and the average (mean) value of 81.47. There are 4 categories of reproductive health attitudes, namely very good, good, fair and not good with the distribution of frequencies and percentages as follows: 146 people (56.2%) are in the very good category, there are 113 people (43.5%) in the good category, there is 1 person (0.4%) in the fair category and not a single person in the bad category. From the data from the descriptive analysis, it was obtained that the average reproductive health attitude of teenagers in Gowa Regency High Schools was in the very good category so it can be concluded that the majority of high school teenagers in Gowa Regency have good reproductive health attitudes.

Teenagers in general have a high curiosity, which often gives rise to their desire to experiment, fantasize and even dare to contradict themselves. Information through the media has

also caused many changes in the sexual attitudes of teenagers in general, there is also sexual exploitation on television, magazines, video clips, online media and even films that are accessed for free on social media which can influence teenagers to engage in free sexual activities (Cahyani et al, 2020).

Factors that influence attitudes are personal experience, influence of other people, culture, mass media, and emotions. Adolescents who have a good attitude regarding reproductive health will also influence the adolescent's attitude in having a positive attitude or not supporting early marriage (Rahayu et al, 2021).

c. Attitudes towards Early Marriage of Teenagers in High Schools in Gowa Regency

Lack of knowledge, and living in a rural area are one of the factors that can influence a person's reasons for marrying at an early age who are still relatively young. An increase in the number of early marriages will have a high-risk impact on early pregnancy as well (Oktavia et al, 2018).

An increase in the number of early marriages will have a high-risk impact on early pregnancy as well. Young women's knowledge about maturing marriage age is limited and this will cause them to be more likely to have negative attitudes. Underage marriages are also very vulnerable to divorce, the result of early divorce in cases of underage marriages puts them in a position that is not ideal, when teenagers should feel love and receive protection, they instead have to face divorce cases caused by underage marriages which take away their lives. in front of a teenager (Oktrarianita et al, 2022).

The results of the descriptive analysis on the adolescent attitude variable towards early marriage obtained were the lowest (minimum) value of 58.00, the highest (maximum) value of 95.00, and the average (mean) value of 81.73. There are 4 categories of reproductive health attitudes, namely very good, good, fair, and not good with the distribution of frequencies and percentages as follows: A total of 139 respondents (53.4) were in the very good category, there were 117 people (45%) in the good category, there were 4 people (1.5%) in the fair category and not a single respondent was in the not good category. So, from the results of the descriptive analysis of the attitudes of high school teenagers in Gowa Regency towards early marriage, they have very good attitudes in responding to early marriage itself.

d. Relationship between Reproductive Health Knowledge and Attitudes and Early Marriage Attitudes among Adolescents in Gowa Regency High Schools

Based on the results of the F test, the significance value of the F variable between the reproductive health knowledge variable (X1) and the reproductive health attitude variable (X2) with the early marriage attitude variable (Y) is $0.000 < 0.05$, and the Fcount value is $13.311 >$ Ftable 3.030, indicating that there is a relationship. between knowledge and attitudes about reproductive health and early marriage among teenagers in Gowa Regency High School.

The close relationship between the independent variable and the dependent variable can be seen in table 1.10 above showing the correlation or relationship value (R) between the variables reproductive health knowledge (X1) and reproductive health attitudes (X2) and early marriage attitudes (Y) which is 0.497 which is in the interval 0.40-0.599 so it is in the "medium" category. The coefficient of determination (R^2) as the contribution value of variables X1 and X2 to variable Y is 0.247. The R^2 value shows the contribution of reproductive health knowledge and reproductive health attitudes to attitudes towards early marriage of 0.247 or 24.7%, while the remaining 75.3% is the contribution of several other factors which also play a role in influencing attitudes towards early marriage among teenagers in Gowa Regency High School.

Based on theory, the higher a person's education, the greater the level of knowledge that will ultimately be implemented in that person's attitude..When a teenager has good knowledge and attitudes towards reproductive health, that teenager will also protect himself so that he does not fall into cases of early marriage, because the teenager understands the negative impacts that will arise if he marries at a too early age (Waroh, 2020).

This is in line with the results of research by Nurhikmah, et al (2021) which states that there are still many teenagers who marry early because teenagers still have low knowledge of the impact of early marriage on reproductive health which is not yet mature and there is still a culture of early marriage in society, as well as The influence of peers who encourage teenagers to have sex prematurely, resulting in teenagers getting pregnant out of wedlock, is a reason for early marriage.

CONCLUSION

Based on the results of the research and discussion previously described, conclusions can be drawn, namely: The results of the descriptive analysis of the reproductive health knowledge variable for high school adolescents in Gowa Regency obtained the lowest (minimum) score was 40.00; The highest (maximum) value was 92.00 and the average (mean) value was 61.69. If seen from the highest frequency and also the average value obtained, then the reproductive health knowledge of high school teenagers in the Gowa Regency can be categorized in the good category. The results of the descriptive analysis of the reproductive health attitude variable obtained the lowest (minimum) value was 61.00, the highest (maximum) value was 90.00, and the average (mean) value was 81.47. The results of the descriptive analysis of the attitude variable toward early marriage among high school teenagers in Gowa Regency obtained a minimum value was 58.00; The maximum value was 95.00 and the average value was 81.73. So it can be concluded that there is a relationship between knowledge and attitudes about reproductive health and early marriage among teenagers in Gowa Regency High School, which has a significant relationship in the strong category.

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Implementation of the ASICC learning model to improve the metacognitive students' based on lesson study extracts

Check for updates

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Article Info

ABSTRACT

This research is driven by observations from the eighth-grade class at Junior High School 5 Kertosono, which revealed that lesson planning, reading comprehension, and problem-solving strategies have not been effectively utilized. Therefore, this research aims to enhance students' awareness and metacognitive skills through the application of the ASICC learning model. The focus of this study is on 18 eighth-grade students at Junior High School 5 Kertosono. This research is classroom action research based on a lesson study conducted over two cycles. The data analysis used is the scores of metacognitive awareness and skills in the first cycle compared to the second cycle, tested using N-Gain analysis. The research results reveal that metacognitive awareness in the first cycle showed that 11.1% of students were in the "medium" category, which increased to 22.2% in the second cycle. Meanwhile, metacognitive skills experienced a significant increase in the "high" category, starting from 16.7% in the first cycle and rising to 33.3% in the second cycle. The ASICC learning model can be applied to enhance students' metacognition. Another finding reveals that students with good metacognitive awareness do not always possess good metacognitive skills.

INTRODUCTION

Indicators of 21st-century educational success emphasize the ability to communicate, share, and use information to solve complex problems (Zubaidah, 2020). True learning is learning that

not only provides knowledge and information to students but also encourages their ability to ask and find answers. Nevertheless, this practice is still rarely used, as the majority of teachers still apply teacher-centric lecture methods. Besides, Indonesia has a science education pattern that is mostly focused on concepts and less on reinforcing metacognitive skills. Since students are not trained to understand and empower their own cognitive abilities, the implication is that students' cognitive abilities are low (Djamahar et al., 2019). Education that focuses on instructors may be more effective in spreading a lot of knowledge in a very short time. However, some educational shortcomings focus on instructors, such as the student's inability to acquire analytical thinking skills and methodical approaches to problem-solving. Students are not encouraged to develop their own skills. And they are not allowed to set a goal and to evaluate what they do well (Ghafar, 2023).

Data collected from a study conducted by Jannah et al., (2023) at the Junior High School 5 Kertosono suggests students are still unable to create effective learning strategies for themselves, such as not being able to understand a read or information properly. They're also unable to make effective learning plans and evaluations. Evaluation is a continuous and recurring process that helps in determining the values of evaluation, educational status, and student achievement (Shinde, 2022). The findings suggest students have a low level of metacognitive awareness, especially in terms of planning, declarative knowledge, and information management strategies. This is because teacher-centered learning is still very frequently used. As a result, students will try to run away if they are tired of the teacher's style of lecture, so they will lag in one topic and face difficulties in the next.

The results of the AKM class examination conducted by KEMENDIKBUD also show that students still have difficulty understanding the purpose of the literacy and numeration questions given. Besides, they seem to be inclined to choose answers reasonably without reading the subject carefully. This is because teachers only concentrate on student worksheets (LKS), which still use type C1 and C2 questions with closed answers. These two categories are the lowest components of Bloom's taxonomy. As a result, they're not used to this type of open answer. Instead, to get a general picture of students' abilities in a particular field, additional testing on other cognitive components, such as analyzing, evaluating, and creating, which are part of the four dimensions of knowledge, is also required (Rahayu, 2018). With LKS, students should be able to undertake activities that are relevant to the material they are taught to train their cognitive skills. Therefore, to improve students' cognitive abilities, ask questions with open answers or use HOTS teaching to direct class activities so that they can explore or acquire students' personal knowledge. Contextual problem analysis and group discussion are two ways that can be used to carry out this activity. On the contrary, teachers are just facilitators of learning, not subjects of learning (Ulfah et al., 2023). Students must participate actively in the learning process, which means they must learn to plan, see, regulate, and control cognitive processes (Az-Zahra et al., 2021).

The above problem causes students to show symptoms of undeveloped metacognition. Metacognition allows a person to study and reflect on how his thoughts happen. Metacognition is simply referred to as "re-thinking what has been thought (Rahmadhni & Chatri, 2023). One of the causes of low metacognitive abilities is the use of learning methods that do not strengthen metacognition abilities. Therefore, learning methods or models can help students improve their metacognitive abilities (Erlin & Fitriani, 2019). By using proper learning design consistently and monitoring student progress, teachers can achieve optimal results by leveraging students' metacognitive abilities (Amin & Adiansyah, 2020). Metacognition awareness and skills are two things to keep in mind when improving metacognition. Metacognitive awareness helps people recognize what they know and what they don't know about tasks to be completed (Eriyani, 2020). Meanwhile, metacognitive skills are essential to regulate and control the cognitive processes

involved in thinking and learning so that learning and thinking become more efficient and productive (Listiana et al., 2019).

Applying the appropriate learning methods, such as the ASICC learning model, is one way to realize such indicators. It is based on the learning of ASICC, which consists of several stages: adapting, searching, interpreting, creating, and communicating, thus helping students solve problems and improve their ability to think systematically. This model also teaches students to work together to solve problems in groups, as well as encourages learning in organized and structured groups (Santoso et al., 2021). Based on the above facts, collaborative skills can be developed or trained in learning so that students become professionals when they work in the real world (Hairida et al., 2021). Metacognition plays an important role in regulating and controlling the cognitive processes involved in thinking and learning.

Based on the issues that have been raised, efforts are needed to enhance metacognitive awareness and metacognitive skills among students. The implementation of action research based on lesson study can be an alternative to enhance the learning process. The reason for choosing action research is based on the result of observation in the schools that there was only one science teacher at that school. Learning needs to be developed collaboratively by several groups of teachers. In addition, the improvement of the quality of the learning process will be maximized if teachers collaborate on planning, implementing, and reflecting on the lessons together. Including how to improve students' metacognitive using lesson study (Shi & Cheng, 2021). Through lesson study, teachers can provide feedback based on their experiences (Roorda et al., 2024). Therefore, by conducting lesson study, teachers can learn from one another, leading to an improvement in the quality of learning.

One of the things that distinguishes this research from previous studies is that this research also compares metacognitive skills with students' metacognitive awareness, whereas previous studies have not extensively addressed research that juxtaposes these two aspects of metacognition.

RESEARCH METHODS
Research Design

This research is an initiation of class action based on lesson study by applying the ASICC learning model to improve students' awareness and skills. The instruments used in this study are a Metacognitive Awareness Inventory (MAI) questionnaire that is distributed with Google Forms, teaching modules, and student worksheets with ASICC stages, pretests, and posts, and application of research based on the model developed by Kemmis & McTaggart, (1988) presented in Figure 1.
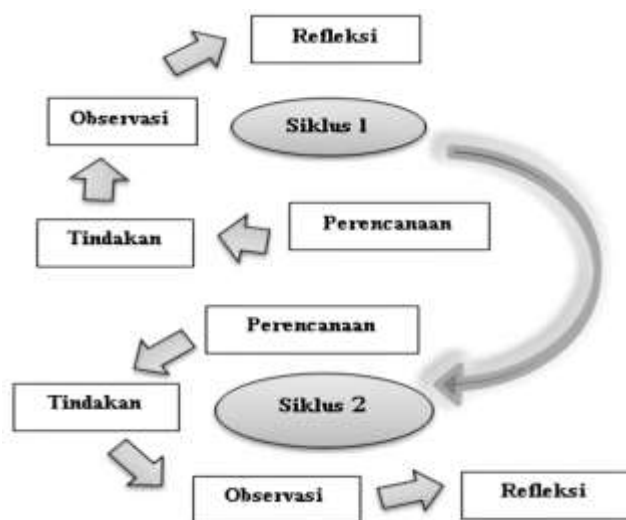

Figure 1. Class action research cycle based on lesson study Model Kemmis & Taggart (1988)

Population and Samples

The study was conducted in September–November of the academic year 2023–2024. The subject of this study is a student in the 8th grade of the junior high school at 5 Kertosono, consisting of 18 students. Results from live observations in the classroom and interviews show that students have a low level of numerical literacy and the presence of low metacognitive symptoms. This is evidenced by the pre-test scores of the Minimum Competency Assessment (AKM), which show a score was 0 on literacy questions related to identifying effective keywords to find relevant information sources in informational texts. On the other hand, all students also face difficulties with numerical problems involving addition, subtraction, multiplication, and division of fractions or decimal numbers, as well as calculating simple probabilities and applying the Pythagorean theorem.

Instruments

The instruments used in this research include a questionnaire to measure metacognitive awareness adopted from Schrow and Dennison (1994), an instrument to measure metacognitive skills integrated with comprehension tests (cognitive) supported by the assessment rubric from Corebima (2009), which was then adjusted to a modified scale interval from Green (2002), teaching modules, and student worksheets (Table 1).

Table 1. Metacognitive Skills Section

Score	Description
0	no answers at all.
1	the answer is not in the sentence itself; the sequence of displaying the answer is less or less false and systematic, logical with less correct grammar (language), which is not accompanied by reasoning (analysis/evaluation, or creation), and the answer isn't true.
2	the answer is not in the sentence itself; the order of displaying the answer is less or less accurate and systematic, logical with less correct grammar (language), which is less accompanied by reasoning (analysis/evaluation, or creation), and the response is less correct.
3	the answer is not in the sentence itself; the order of displaying the answer is less or less accurate and systematic, logical with less correct grammar (language), which is less accompanied by reasoning (analysis/evaluation/creation) and the reply is true.
4	the answer is not in the sentence itself; the sequence of displaying the answer is chaotic and systematic, logical with the grammar (language) right, which is accompanied by the reasoning (analysis/evaluation/creation) and the reply is true.
5	the answer in the sentence itself, the sequence in which the answer is displayed, is blatant and systematic, logical with less correct grammar (language), which is accompanied by reasoning (analysis/evaluation, or creation), and that answer is true.
6	the answer in the sentence itself, the sequence of the display of the answer, is less accurate and systematic, less or less logical, with the grammar (language) less correct, which is accompanied by the reasoning (analysis/evaluation, or creation), and the reply is true.
7	the answer in the sentence itself, the sequence in which the answer is displayed, is smooth and systematic, logical with the grammar (language) right, which is accompanied by the reasoning (analysis/evaluation, or creation) and the answer's right.

These instruments were developed during the planning stage of the lesson study. Then, a focus group discussion (FGD) was conducted by the teachers of the science subject, the research team, expert lecturers in biology education, expert lecturers in biology, and supervising lecturers.

The purpose of the FGD is to assess the feasibility of the teaching materials and instruments that will be used. The results of the focus group discussion revealed that the teaching instruments and materials are deemed very suitable but need improvement. The instruments have been revised according to the recommendations from the FGD results (Table 2).

Table 2. Metacognitive Skill Scale Interval

Value Interval	Level	Name	Description
0-17	0	not yet	not leading to cognition
18-34	1	a lot less	it seems to have no consciousness of thinking as a process.
35-51	2	Less	unable to separate what he thinks from the way he is thinking
52-68	3	Growing	can help towards self-consciousness if supported.
69-85	4	Good	the conscious will think for himself and can distinguish between the stages of elaboration of input and output in his mind. sometimes using strategies to organize his thinking and learning.
86-102	5	very good.	able to use metacognitive skills regularly to regulate their own thinking and learning processes. be aware of the many possibilities of thinking, be able to use them, and reflect on the thinking process.

Procedures

The data collection began with an interview with natural science teachers in the 8th grade about the teaching and learning process, as well as direct observations of the difficulties encountered by teachers and students during the learning process. Students were asked to fill out the MAI lift to find out metacognitive awareness and pre-test previous material. This study consists of two cycles or six meetings, with four elements each: 1) Researchers and natural science teachers carry out the planning phase by preparing teaching modules, leaflets for teachers, and post-test issues to be given to students. 2) The action phase is carried out using the instruments that have been made, and the natural science teacher acts as a model teacher. 4) At the observation stage, two researchers acted as observers during the ASICC learning model, where the main task of the observers was to observe the classroom conditions when the learning began, as well as to note and record both photos and videos related to the responses of 18 eighth-grade students from Kertosono Junior High School during the learning process. 5) The phase of reflection is performed by the teacher and the researcher after the lesson material is completed to see how successfully the learning is implemented.

Data Analysis

The data analysis of this research is derived from data on awareness and metacognitive skills. The measurement of metacognitive awareness is conducted using a modified MAI questionnaire, which is divided into two types: knowledge about cognition and regulation of cognition. The rubric in the metacognitive questionnaire consists of scores on a scale of 0-3. The assessment rubric for the results of the metacognitive awareness questionnaire can be seen in Table 3.

Table 3. Metacognitive Awareness Rubric

Skor			Description
0	TP	=	Never experienced as described in the statement.
1	JR	=	Rarely experiencing as described in the statement.
2	SR	=	Often experiencing according to the description of the statement.
3	SL	=	Always experiencing according to the description of the statement

The data collected from the MAI questionnaire was analyzed using average calculations with Microsoft Excel 2010 based on formulas.

$$\bar{x}\text{ student scores} = \frac{P}{TN}$$

Information:

TN = Total number

$\bar{x}$ student scores = Average student scores

P = Point

Meanwhile, the results of the metacognitive skills assessment were obtained from the post-test conducted by each student. The assessment is based on a rubric modified from Corebima (2009), which will be accumulated and converted into a score on a scale of 100 as per the following formula.

$$X = \frac{Y - \text{Min Score}}{\text{Max Score} - \text{Min Score}} \times 100$$

Information:

X = The value of metacognitive skills.

Y = The scores obtained by the students.

Next, to determine the level of metacognitive ability by matching the modified scale intervals from Green (2002). After all the stages are completed, the next step is normalization using the N-Gain formula and determining the criteria for the N-Gain values (Table 4).

$$N - \text{Gain} = \frac{\text{Post Test Score} - \text{Pre Test Score}}{\text{Maximum Score} - \text{Pre Test Score}}$$

Table 4. Creteria N-Gain

Normality Value Gain	Criteria
$0{,}70 \leq n \leq 1{,}00$	High
$0{,}30 \leq n < 0{,}70$	Moderate
$0{,}00 \leq n < 0{,}30$	Low

RESULTS

The results of the observation on the implementation of the ASICC learning model show that in the adapting stage of the first cycle, students were less focused on listening to the lesson and talking about things unrelated to the subject matter. The teacher then gave a reprimand and thought-provoking questions to the students. At the searching stage, students use their phones to open other applications that are not related to the lesson material, so the teacher must ensure that students are using their phones to look for additional information related to the lesson content.Because the students are not accustomed to the heterogeneous group system, at the interpreting stage, the male students appear to be more active compared to the female students. Therefore, the teacher posed several questions to stimulate the students' curiosity, and in the final stage, which is creating and communicating, the students were still shy to express their opinions and ask questions because they were afraid of making mistakes in their tasks and feared the feedback from other groups. As a result, the teacher's efforts included providing motivation to help them feel prepared and confident in delivering their presentations.

The second cycle shows an increase, with students more focused during the adaptation phase and wanting to ask questions about the material presented. At the searching stage, students become

active and enjoy learning, as indicated by their observation results. Students have started using their phones to search for information related to the material, are accustomed to discussions related to practical work conducted in a heterogeneous manner, are able to present their work even though they sometimes use their local language, and are beginning to feel confident in asking questions and providing critiques and suggestions about the presentations of other groups.

In addition to the classroom observation results, there was an increase in the average metacognitive awareness of students, as obtained from the MAI questionnaire administered at the end of each cycle. What can be seen in Figure 2.
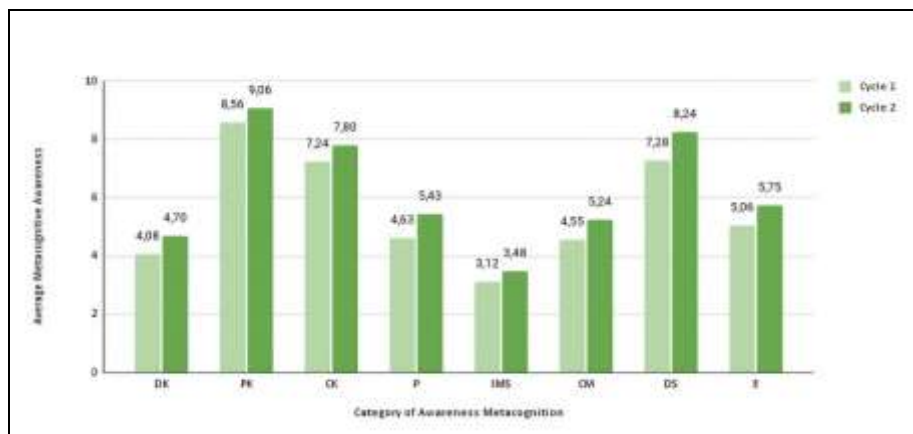

Figure 2. Average Metacognitive Awareness of Students

*DK=Declarative Knowledge; PK=Procedural knowledge; CK=Conditional knowledge; P=Planning; IMS=Information management Strategies; CM=Comprehension monitoring; DS=Debugging strategies; E=Evaluation.

In addition to the classroom observation results, there was an increase in the average metacognitive awareness of students, as obtained from the MAI questionnaire administered at the end of each cycle. This can be seen in Figure 2. The procedural knowledge category has the highest score compared to other categories. Students achieved an average score of 8.56 in the first cycle and an average score of 9.06 in the second cycle. Based on Figure 2, the debugging strategies in the first cycle had an average score of 7.28, which is lower than the second cycle's score of 8.24. This indicates that students were able to find the right strategies to correct their misunderstandings in learning, as they have started to bravely ask questions about material they do not understand and seek help from others to avoid confusion.
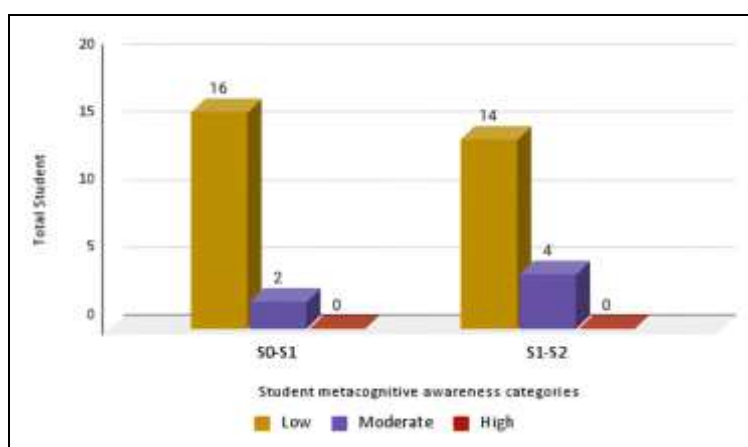

Figure 3. Results of N-Gain Metacognition Awareness Test Calculation.

The results of the metacognitive awareness test calculation based on Figure 3 show that 16 or 88.9% of students are still in the "low" category, while only 2 or 11.1% of students are in the "medium" position. After the ASICC learning was conducted over two cycles, the number of students experiencing metacognitive awareness in the "medium" category increased to 4 students, or 22.2%.
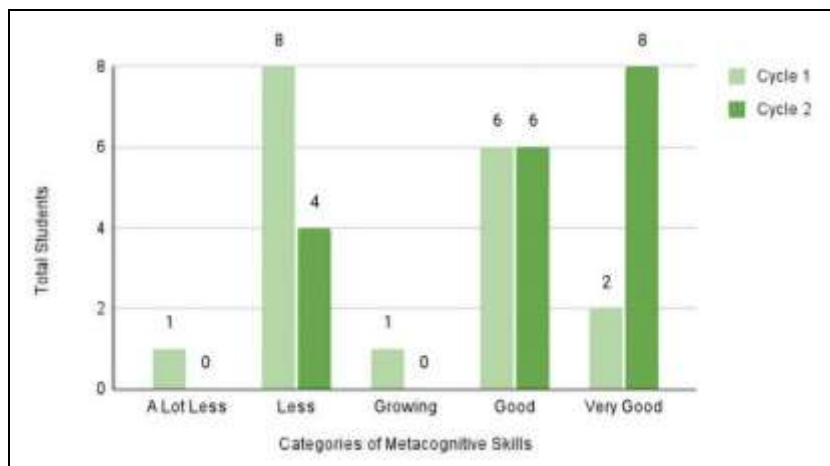

Figure 4. Results of the N-Gain Calculation For Metacognitive Skills.

Meanwhile, the number of students based on the results of the pre-test and post-test using the metacognitive skills assessment rubric and scoring with Green's scale can be seen in Figure 4. The implementation of the ASICC learning model conducted over two cycles shows a significant difference in students' metacognitive skills. The notable difference is evident in the "very good" category, where in the first cycle, 2 students, or 11.1% fell into this category, while in the second cycle, there was an increase to 8 students, or 44.4%.
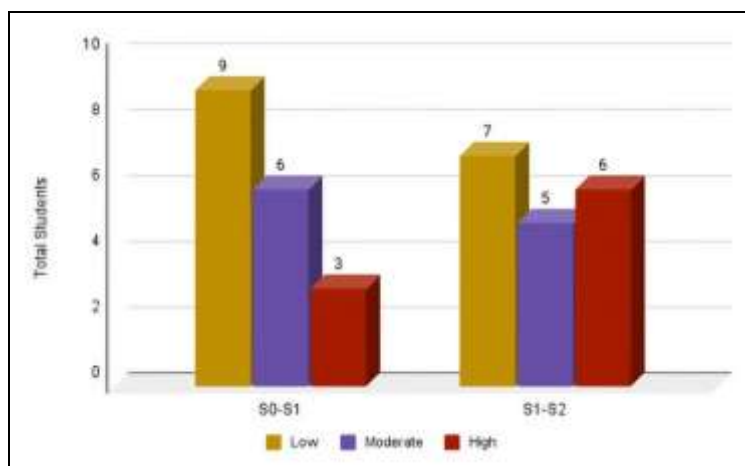

Figure 5. Metacognition Skills N-Gain Test Results Calculation.

The results of the N-Gain test calculations for metacognitive skills also show an increase, as can be seen in Figure 5. During the first cycle, there were 9 students, or 50%, in the "low" metacognitive skills category. The metacognitive skills in the "high" category showed a significant improvement. In the first cycle, there were 3 students or 16.7%, and in the second cycle, it increased to 6 students or 33.3%. This can also be observed during the learning process, especially in the stages of interpreting, creating, and communicating. Students are more active in asking

questions and responding to the statements of the teacher and group members compared to the previous cycle. They also participate in practical sessions and focus more on the tasks assigned by the teacher.

Table 5. Presentation of the N-Gain Metacognition Analysis Results

Metacognition category	Metacognition awareness (%)	Metacognition skills (%)
Low	72,2	22,2
Low – Moderate	16,7	16,7
Moderate- Low	5,6	11,1
Moderate	5,6	5,6
Moderate – High	0	16,7
High – Moderate	0	5,6
Low – High	0	11,1
High – Low	0	5,6
High	0	5,6

The percentage results of the N-Gain acquisition from the data on metacognitive awareness and skills are presented in Table 5. The percentage of N-Gain analysis results on metacognitive awareness and skills from the two data sets revealed that students with high metacognitive awareness do not always possess high metacognitive skills as well. This can be seen in Table 5, which shows that students with low metacognitive awareness have a percentage of 72.2%, while students with low metacognitive skills have a percentage of only 22.6%. Furthermore, Table 5 indicates that 5.6% of students in the high metacognitive skills category do not show that they possess metacognitive awareness in that category.

DISCUSSION

The research was carried out at the 5th Kertosono Junior High School to raise the awareness and metacognition skills of students with the help of teaching modules and worksheets integrated with the ASICC-based learning model. Lesson Study collaborated with teachers of natural sciences, who acted as facilitators, and researchers, who acted as observers. The teaching module and worksheets used consist of five stages: adapting, searching, interpreting, creating, and communicating. In the adapting phase, teachers provide stimuli that can enhance students' ability to evaluate their own learning goals, images, and videos to stimulate students' knowledge and curiosity. These stimuli enable students to reflect on information that they knew and that they did not know at the beginning of learning. The second stage is searching. Students can search for as much information as possible through the internet or through people who are experts in a particular field according to the subject they are studying. In addition to the interpreting stage, students can take part in activities or conduct workshops designed to encourage group discussion. The final stage in ASICC learning is creating and communicating. At this stage, students are asked to create a product in groups, such as an idea, prototype, or other form of learning product, which is then submitted to another group to get feedback. (Santoso et al., 2021).

Metacognition consciousness research results are based on MAI instrumental responses completed by students in pre-cycle and post-test results following the application of the ASICC-based lesson study learning model to natural science subjects. The data shows that the entire component of metacognitive consciousness is improving with each cycle. Significant improvements are seen in procedural knowledge and debugging strategies, and such improvements mean students can find appropriate and systematic problem solutions The intended solutions include consulting with a teacher or expert when finding a problem, changing the learning approach when it fails,

reassessing an existing understanding, and re-reading parts that are not understood (Wiono et al., 2021).

This increase in metacognitive awareness is also evident during the learning process, especially when students answer questions on the worksheets about the respiratory and excretory systems. At the beginning of the learning process, students are already aware of the learning objectives, allowing them to understand what activities need to be undertaken regarding the material. This increase in metacognitive awareness is marked by the ability to solve problems, acquire skills to reflect creatively and independently on what has been learned and improve in remembering and mastering what has been studied (Rasyida, 2022)

This learning model also involves practice so that students understand which strategies should be used to ensure that the practice is successful. Students begin to work together, collaborate, feel brave to ask questions and express opinions during the stages of interpreting, creating, and communicating about what they know as well as what does not align with their thoughts. Another piece of evidence was presented by student A.N., who is usually not active in class, during the observation, who expressed a desire for the next material to be done in groups because the material is easier to understand when discussed collectively. Another student named D is interested in doing the practice and is willing to be appointed by the teacher to demonstrate in front of his classmates. At the practical stage, students can operate the tools and materials used for simple practices with recycled items in groups, illustrate the parts of the practical tools related to human organs and their functions, and create posters about the excretory and respiratory systems. In addition, the interpreting stage worksheet also contains open-ended questions that allow them to use their methods to find new answers (Polin et al., 2022)

After performing a percentage analysis of the gain normalization results, awareness, and metacognition skills of both such data there is a finding that students who have good metacognitive awareness do not always have good meta-cognition abilities as well. This can happen because they possess metacognitive awareness in the form of good planning, but they have not yet been able to apply ideas or concepts from various perspectives in their learning process. Additionally, students have different learning styles; some students easily learn or understand the metacognitive awareness they have, even though they are not yet able to use their metacognitive skills regularly to apply and reflect on their thinking processes, and vice versa. This can also happen due to the differences in the causes of awareness or the level of metacognition that each student possesses (Alkadrie et al., 2015).

CONCLUSION

Classroom action research based on a lesson study applied to eighth-grade students at State Junior High School 5 Kertosono shows that students are starting to actively ask questions, understand readings, and solve problems in groups. Therefore, the ASICC learning model helps students enhance their awareness and metacognitive skills. The improvement is reflected in the student's metacognitive profiles, where in the first cycle, 11.1% of students were in the "medium" category according to the N-Gain test of metacognitive awareness, and this increased to 22.2% in the second cycle. Metacognitive skills showed a significant increase in the "high" category, with 16.7% of students in that category during the first cycle, rising to 33.3% in the subsequent cycle. The findings also indicate that students with good metacognitive awareness do not always possess strong metacognitive skills.

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The learning strategy for biodiversity concept: Pedagogical analysis based on technological pedagogical and content knowledge

UPDATE

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Article Info	ABSTRACT
	Sustainable Development Goals (SDGs) emphasize quality education and environmental protection. Biodiversity education in Phase E requires students to solve problems related to biodiversity. However, complex terminology and limited learning tools create challenges. This research aims to analyze effective learning strategies for teaching biodiversity using a TPACK framework. The method used in this research is a literature review carried out systematically by PRISMA. The analysis will map pedagogical approaches, content based on CoRes analysis, and technological aspects. Findings will inform the development of effective learning strategies for high school biodiversity education, contributing to achieving SDGs, particularly SDG 15 on terrestrial ecosystems. The finding shows that The use of CoRes to narrow down the information is required to instruct students and promote the attainment of the 15th SDG goal. Based on the findings of the analysis, the pedagogical review of the approach used, namely local wisdom, the field trip method, and the discovery learning model, as well as the use of technology to assist students in identifying PlantNet, Picture This, and iNaturalist, is considered effective to be implemented in learning biodiversity material.

INTRODUCTION

A key component of the 2030 agenda is the 17 universal, transformational, and inclusive sustainable development goals (SDGs). The SDGs describe the major development challenges

facing humanity. The SDGs address a wide range of social needs such as education, health, social protection, and employment opportunities while addressing climate change and environmental protection (UNESCO, 2017). Concerning the above, especially education, all students must have access to the knowledge and skills needed to support sustainable development, by the fourth goal of the SDGs, namely quality education (Agirreazkuenaga, 2019; Aleixo et al., 2020; Yuan & Wu, 2021; Zhang et al., 2020).

Following up on the fourth SDG goal, improving the quality of education in Indonesia is the responsibility of all from the government, and education sector institutions including teachers, students, and parents. (Zidan et al., 2023). All countries agree that education comes first. The quality of education is an important factor in the progress of a nation. In other words, the progress of a nation or country can be seen from the quality of its education (Kurniawati, 2022). Teachers play a very important role in the development of the education sector. Teachers are people who teach children in formal schooling, primary and secondary schools. Teachers are the core of education without active participation and the quality of a teacher determines the quality of education (Siregar, 2020). Teachers are responsible for meeting all the needs of their students, so they must have the necessary abilities and competencies to educate students professionally. The purpose of teacher professional development is to improve the quality of teachers (Risdiany, 2021). The use of technology in teaching is one of the many approaches that have been used to improve teacher professionalism, including the use of technology in teaching. The movement into the digital age has impacted not only the social system but also the education system (Rochintaniawati et al., 2019). To utilize technology in the learning process, teachers must have the ability to combine technological skills, pedagogy, and learning content knowledge. This ability is known as technological content knowledge (TPACK) (Rahayu et al., 2023).

TPACK is a theoretical framework used to combine technology, learning (pedagogics), and subject matter in the learning process it consists of content (Koehler & Mishra, 2009). Technological Pedagogical Content Knowledge is a combination of three main components that serve as a framework for designing learning. In addition to the technological component in TPACK, pedagogy is an important component in understanding learners in psychological and biological learning. Pedagogy emphasizes that successful teachers are not just people who know how to make students smart; they are teachers who help students discover, their interest and their character. (Purnawati et al., 2020)(Nofrion et al., 2018).

In biology learning, biodiversity material is one of the important subjects. Biodiversity material is material whose object of study is very broad. The objects that become the study material are things that are often encountered in the real world, so it needs a strategy for how to teach students the concept of biodiversity (Fitria et al., 2017). The implementation of this biodiversity material is implicitly listed in the biology learning phase E 10th knowledge element students are expected to be able to create solutions to problems based on local, national, or global issues related to understanding the diversity of living things and their role. These efforts are directed to support the achievement of sustainable development goals (SDGs) (Kemdikbud, 2022) especially goal 15th on terrestrial ecosystems. Goal 15 addresses protecting, restoring, and enhancing the sustainable use of terrestrial ecosystems and halting biodiversity loss (Bappenas, 2020). The material on biodiversity is enough to make students have difficulty in understanding the material, where as many as 65.5% higher students said it was quite difficult, so in studying biodiversity material 44.8% higher students chose quite necessary to be given other teaching media. The shortcomings of the teaching media used in biodiversity material so far, 37.7% more students chose because the explanation of the material was too dense and used complicated language. The Students still struggle when learning the concepts of biodiversity due to the use of complicated terminology, abundant content, the use of many concepts, and the lack of easy-to-understand learning tools

(Sarip et al., 2022). Therefore, pedagogical analysis is needed to identify effective learning strategies for teaching TPACK-based biodiversity materials. The framework of effective learning strategies is expected to be a guide to help teachers develop the learning to be achieved.

The research conducted has a novelty, namely providing learning suggestions based on the TPACK framework that considers the teacher's content skills based on the depth and length of the material, pedagogics in biodiversity material, and the use of technology as a learning medium to make it easier for the student to understand better biodiversity material which is adjusted to phase E learning outcome (Capaian Pembelajaran). This research aims to analyze the learning strategies implemented on biodiversity materials. The mapping in the analysis will be based on TPACK which focuses on pedagogical aspects in the form of skills, approaches, models, and methods, material content aspects based on CoRes analysis (content representation), and technological aspects on biodiversity material. Therefore, this research examines how effective learning strategies can be applied to the concept of biodiversity at the high school level.

RESEARCH METHODS

Research Design

The method used in this research is a literature review carried out systematically by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines developed by Page et al (2021) by analyzing relevant international and national articles and focusing on TPACK as a learning strategy for biodiversity material.

Population and Samples

The population in this study includes scientific works that have been published in various academic databases, university repositories, and other scientific sources that discuss TPACK in teaching biodiversity. By using a purposive sampling technique, samples were obtained in the form of reputable journal articles, both national and international, which studied TPACK in teaching biodiversity from 2019 to 2024.

Instruments

The types of articles used in this literature review were obtained through Harzing's Publish or Perish software using Google Scholar, Scopus, Crossref, and Semantic Scholar databases by entering keywords: TPACK, learning strategies, learning models, learning methods, learning approaches, learning media, and biodiversity, and by filtering the year range from 2019 to 2024.

Procedures

The literature review used in the research follows PRISMA guidelines, the procedure of which consists of identification, screening, and inclusion stages. In the identification stage, researchers define research questions clearly and specifically, namely regarding learning strategies for biodiversity material according to the TPACK components. Then proceed with searching for samples of research articles using Harzing's Publish or Perish software. The articles that have been found are then summarized into tables to organize the extracted data complete with bibliographic information (title, author, year, publishing journal, etc). In the screening stage, duplicate articles were removed and initial screening was carried out on titles and abstracts that were irrelevant or did not meet the predetermined inclusion criteria. Then a full-text review is carried out and an article quality assessment is carried out to see whether the article has a significant risk of bias or not. At the inclusion stage, articles were included that met all inclusion and exclusion criteria and had qualified methodological quality.

Significant risk of bias was evaluated using an article quality assessment method based on PRISMA guidelines. This assessment covered various aspects, such as the appropriateness of the research design, data collection, and analysis, as well as the validity of the data used. Additionally,

potential conflicts of interest that could influence the research outcomes were examined to ensure that the included sample articles had a low risk of bias and were reliable.

Data Analysis

Data analysis in the PRISMA literature review method involves synthesizing findings from various studies to identify patterns, differences, and gaps in the literature. The aspects analyzed include the effectiveness of integrating TPACK into biodiversity teaching material, the diverse pedagogical strategies employed (approaches, methods, and learning models), how technology is harnessed to enhance content understanding, and the challenges encountered in implementing TPACK. This analysis also evaluates how these strategies align with educational goals and highlights areas needing further research to optimize biodiversity teaching strategies through the TPACK framework.

RESULTS

Based on the results of the literature review, 16 research articles were identified that examined the implementation of TPACK in biodiversity learning materials. The results of the empirical studies related to these articles are presented in Table 1.

Table 1. The Empirical Study on the Implementation of TPACK in Biodiversity Materials Research

No	Authors'	Scope
1	Ramdiah et al (2020)	Local wisdom approach to biodiversity material
2	Sunarsih et al (2020)	Biodiversity module based on local wisdom with discovery learning model
3	Kuswanto et al (2021)	Guided inquiry learning model for biodiversity material
4	Anwar et al (2021)	Problem-based learning model for biodiversity material
5	Shabrina et al (2024)	Problem-based learning model with integrated ESD approach to biodiversity material
6	Amelia et al (2021)	Handbook of biodiversity with a contextual approach
7	Tupas (2019)	Biodiversity teaching materials contain local wisdom with the contextual approach
8	Nugraha & rachmadiarti (2022)	Flipped Book of STEM-based biodiversity material
9	Linawati et al (2023)	Constructivism approach to discovery learning model of biodiversity material
10	Rahma et al (2024)	Field trip method on students' understanding of biodiversity material
11	Fatimah et al (2023)	Learning biodiversity material using the STEM integration PjBL model
12	Nurmaliah et al (2020)	Implementation of the PjBL model in biodiversity material
13	Wilsa et al (2023)	Plant identifier application's capabilities for biology education to plant identification and classification.
14	Mu'minah et al (2023)	Efficacy of the field trip approach with the use of Plantnets as a medium for plant identification
15	Echeverria et al (2021)	Collaborative project with biology students on a citizen science project with iNaturalist.
16	Yusni et al (2023)	Biodiversity learning through an environmental approach, based on local wisdom, assisted by the iNaturalist application.

DISCUSSION

Learning materials and scopes

Based on the Merdeka curriculum in phase E, the learning outcomes (Capaian Pembelajaran) are "At the end of phase E, students can create solutions to problems based on local, national or global issues related to understanding the diversity of living things and their role, viruses and their role, biological technological innovation, ecosystem components and interactions between components and environmental changes". Putra & Kinasih (2023) described the depth and length of biodiversity material in Table 2.

Table 2. Depth and Length of Biodiversity Material

Depth	Length
Biodiversity Concept	Diversity in gene, species, and ecosystem level
Indonesia: World Biodiversity Center	Diversity of Endemic Flora and Fauna of Indonesia
Utilization of Indonesia's Biodiversity	Food, Clothing, Board, Health, Energy, Industry, Science and technology
Threats to Biodiversity	Factors Affecting Biodiversity, Endangered and Protected Flora and Fauna
Biodiversity Conservation	Maintaining Forest Sustainability, Determine In Situ and Ex Situ Natural Protection Areas

According to Table 2, we are analyzing the scope of biodiversity learning which is grouped into 4 major characteristics: Content characteristics, dimension of knowledge, difficulty level, and complexity. The development of biodiversity learning media provides direct and concrete learning experiences for students (Pratiwi, et al., 2019). Bridging biodiversity learning in schools with concrete learning experiences is crucial to fostering a deeper understanding and appreciation for the natural world. Concrete learning, as defined by Jerome Bruner (1966), emphasizes hands-on, experiential approaches to grasp abstract concepts.

Biodiversity has a wide range of material that has concepts and theories that can be applied in everyday life (Kusumawardhani and Indana, 2021). Especially in Indonesia which has a broad and rich biodiversity (Dewi et al, 2020). Ngabekti et al. (2021) described the characteristics of biodiversity as clear, contextual/factual. Effective biodiversity learning requires a balance between factual knowledge and conceptual understanding. While memorizing facts about species, ecosystems, and biological processes is essential, it is equally important to develop a deeper comprehension of the underlying principles that govern the natural world (Ausubel, 1960).

Based on a preliminary study conducted by Septian (2018) revealed that 10 out of 14 students faced difficulties in determining the appropriate level of biodiversity, whether genetic diversity, species diversity, or ecosystem diversity, based on the provided examples. The study of biodiversity has a broad enough concept that students find it difficult to understand the material, as well as the level of material difficulty that is quite high, such as the level of genetic diversity and species, the distribution of flora and fauna according to Wallace and Weber lines (Arifin et al., 2021; Novita et al., 2022; Dewi et al., 2020).

Determining the big idea as content representation (CoRes)

Effective science teaching requires more than just scientific knowledge. Science teachers also need to understand their students, the curriculum, and various teaching methods and assessments. This allows them to transform scientific knowledge into engaging learning experiences for their students (Susilowati, 2017). CoRes (Content Representations) is a tool that helps teachers unpack

their knowledge about teaching specific science topics to particular student groups. CoRes guides teachers through key questions, prompting them to consider the content, student understanding, learning objectives, and appropriate teaching strategies. Bertram & Loughran (2011) offered the CoRes framework to science teachers. The 'Big Idea' is meant to represent the major idea and concept within the particular science content area. According to this research, we are going to analyze the topic of biodiversity learning based on the CoRes framework.

The CoRes framework which is analyzed in this research based on Table 2 offers a valuable tool for educators aiming to effectively teach the concept of Indonesia as a mega biodiversity country. This structured approach highlights key learning objectives, addresses potential challenges, and outlines engaging teaching strategies. By carefully considering these elements, teachers can ensure students grasp the significance of Indonesia's rich biodiversity.

The CoRes emphasizes several key learning points for students. Firstly, it aims to instill an understanding of Indonesia's unique position as a mega biodiversity country. The framework underscores the critical importance of biodiversity for environmental health, ecological balance, and human well-being. Additionally, students will develop a foundational understanding of core biodiversity concepts like species diversity, ecosystem diversity, and genetic diversity. Finally, the curriculum equips students with knowledge of current and future environmental challenges related to biodiversity loss, empowering them to become informed stewards of their environment.

The CoRes framework goes beyond simply outlining these learning points. It also offers a toolbox of engaging teaching strategies. Teachers are encouraged to begin by clearly defining and explaining biodiversity, emphasizing its importance and benefits. Real-world connections are fostered by presenting case studies and examples of biodiversity phenomena specific to Indonesia. Thought-provoking questions further engage students and stimulate their curiosity, encouraging critical thinking skills. Citizen Science Projects (CSPs) as Aripin et al (2021) carried out, provide a valuable platform for hands-on learning and application of these newly learned biodiversity concepts. Finally, the framework promotes the development of critical thinking skills, as students analyze and propose solutions to biodiversity conservation challenges.

By utilizing CoRes, teachers can design lessons that are tailored to their students' needs and learning styles. This framework helps them identify the most effective ways to present the subject matter, ensuring students grasp the importance of the material and engage with the learning process (Susilowati, 2017).

Learning approach based on research sources

An approach is a strategy for achieving learning objectives chosen when designing learning (Widodo, 2021). The learning approach is an important component because it can influence the way students understand and absorb learning material. Thus the learning approach must be adapted to the needs, interests, and level of understanding of students. Based on the results of the literature review, there are four types of approaches to learning strategies for biodiversity material, they are contextual, local wisdom, constructivism, and integrated approaches.

The contextual approach is a learning strategy that helps students connect the concept of material with real experiences or situations. Biodiversity material is very close to students' lives because it covers various aspects of the environment that students encounter every day, such as local flora and fauna around students, as well as practices such as agriculture and conservation that may be implemented in communities. Therefore, a contextual approach is suitable for use in biodiversity material. The contextual approach allows students to relate biodiversity concepts to students' real experiences so that learning becomes more relevant and easy to understand. As in research by Amelia et al (2021), the development of a biodiversity handbook by utilizing the Bintan coastal environment was able to increase student motivation and learning outcomes. Then in Tupas (2019), it was stated that the use of biodiversity in the Sampunong Bolo Wildlife Reserve in Sara

Municipality, Iloilo, Philippines was able to create enjoyable learning for students so that students were comfortable learning and had an impact on student learning outcomes. By observing biodiversity directly, students can link the theory learned in class with reality in the field, so that their understanding becomes deeper and more meaningful. This is because the information received is not only stored in short-term memory but can be stored in long-term memory (Amelia et al., 2021).

The local wisdom approach is an integral part of the contextual approach because it connects learning material with students' real experiences and environments (Ramdani, 2018). The local wisdom approach has become a research trend in studying biodiversity material. Local wisdom is an important part of understanding the culture and life of a community which cannot be separated from the community itself because it is a constructive identity that must be maintained and at the same time becomes a filter, so that it is not eroded by foreign culture (Afif, 2022; Lenga et al., 2024; Jumriani et al., 2021). In the Merdeka Curriculum, local wisdom is one of the themes of the project to strengthen the profile of Pancasila students, which is specifically a form of implementation of the global diversity dimension. Integrating local wisdom as material content in biology learning makes it easier for students to understand the material thereby supporting the achievement of learning objectives (Festiyed et al., 2022; Sriyati et al., 2022). Apart from theoretically strengthening students' cognitive abilities, this can also strengthen students' attitudes and skills. This is as shown in research by Sunarsih et al (2020) that the development of a biodiversity module containing local potential, apart from improving student learning outcomes on biodiversity material, is also able to train an attitude of caring for the environment. This is confirmed by Karmadi et al (2023) that folklore as a source of student learning on biodiversity material can train critical, creative thinking skills and an attitude of caring for the environment.

The constructivism approach is a learning strategy in which educators act as facilitators and guides, allowing students to explore their knowledge and develop scientific concepts through learning experiences (Yuliani, 2021). Constructivist learning theory emphasizes the importance of interaction in the process of acquiring knowledge, with teachers playing an important role in directing and supporting students during the learning process (Kibirige, 2021). This approach encourages students to actively engage in their learning, connect new knowledge to previous experiences, and build deeper understanding through reflection and discussion. This is as in research by Linawati et al (2023) which explains that learning biodiversity material using a constructivist approach makes students more active in the learning process. Thus, students not only receive information passively but also actively participate in the learning process.

Learning biodiversity material using an integrated STEM-ESD (Science, Technology, Engineering, Mathematics - Education for Sustainable Development) approach is an innovative step in education that combines science and technology with the principles of sustainable development. This approach not only focuses on a theoretical understanding of biodiversity but also invites students to engage in practical projects involving engineering, mathematics, and technology to solve real environmental problems Fatimah et al (2023). Learning tools have a crucial role in the educational process, as they provide the structure, resources, and guidance necessary for teachers and students to achieve learning goals. ESD-laden learning devices can increase students' scientific literacy (Shabrina et al., 2024). Apart from that, research by Nugraha & Rachmadiarti (2022) also explains that STEM-based flipped books as a learning tool can improve students' critical thinking abilities.

Learning model based on research sources

Based on the results of the literature review, there are four types of learning models in biodiversity material, discovery learning, guided inquiry, problem-based learning, and project-based learning models. The discovery learning model is a learning model that makes learning student-

centered so that students are encouraged to be more active and understand concepts, meanings, and relationships through an intuitive process to reflect on a teaching and learning activity (In'am A & Hajar S, 2017; Yuliani, 2021). Learning biodiversity material using the discovery learning model can increase students' learning motivation because they are directly involved in discovering a concept through examples and phenomena found in the students' environment (Steward, 2023; Sunarsih et al., 2020). Apart from that, research by Linawati et al (2023) also stated that student learning outcomes on biodiversity material using the discovery learning model increased.

Apart from the discovery learning model which makes students actively involved in discovering concepts, the guided inquiry model is also able to encourage students to be actively involved in the learning process through exploration, observation, and discovery. In the biodiversity learning material, through the guided inquiry learning model students are allowed to directly observe various plant and animal species in the environment around them, carry out simple research, and analyze the data they collect (Kuswanto et al., 2021). With teacher guidance, students learn to formulate questions, design experiments, collect and interpret data, and draw conclusions based on the evidence found, so that learning is more meaningful.

The problem-based learning (PBL) model is a learning model that uses problems that occur in the student's environment to teach a concept to develop critical thinking and problem-solving skills. The problem-based learning model is the right choice for teaching biodiversity material, including issues surrounding the protection and conservation of biodiversity. Through PBL, students not only learn about biological concepts but are also actively involved in solving real problems related to biodiversity. They are invited to identify problems such as habitat loss, species extinction, or environmental degradation, and then look for sustainable solutions. This is as in the research of Komala et al (2021) and Anwar et al (2021) that the problem-based learning model influences students' argumentation and problem-solving abilities regarding learning material on biodiversity issues.

Starting from the case of problems that threaten biodiversity, problem-solving skills alone are not enough to solve these problems. Students need to be equipped with creativity to face various challenges and problems that arise. One real example is project creation. In the project, students are expected to use their imagination and knowledge of biodiversity to solve problems that arise. For example, they may design conservation projects to protect endangered species or create ecosystem mock-ups that reflect the diversity of plants and animals in a region. The Project Based Learning (PjBL) model is a learning model that provides the opportunity to work independently to construct knowledge through creating projects based on the things learned. In research by Fatimah et al (2023) and Nurmaliah et al (2020), the PjBL model was able to increase students' creativity in biodiversity material.

Learning methods based on research sources

Learning methods are not only a strategy for delivering learning material, but also a link between students and comprehensive knowledge. By utilizing variations in learning methods, teachers can accommodate the different learning styles of each student, strengthen their understanding, and increase learning motivation. When studying biodiversity material, students' lack of knowledge about biodiversity and environmental sustainability occurs because students only learn in the classroom and school environment, so they do not enjoy the environment outside of school (Rahma et al., 2024). This problem can be overcome by using the field trip method. The field trip method can teach real biodiversity material and provide informal learning opportunities for students with an emphasis on cultivating a sense of enjoyment, interest, and curiosity so that this method can increase knowledge of biodiversity and environmental sustainability attitudes among students (Hassan et al., 2022; Rahma et al., 2024).

The field trip method can be used well if students have learning styles outside of school. Therefore, before using the field trip method, teachers must first know what students' learning styles are. Some students may tend towards a visual learning style, so direct experience through field trips can strengthen students' understanding. However, for students with other learning styles, the field trip method is less effective. Thus, teachers must pay attention to variations in student learning styles when planning field trips so that learning will be optimal.

Learning media based on research sources

The important thing to learn from biodiversity material is to identify plants or animals based on taxonomy or grouping of living things based on their characteristics. Ex. plants are often identified by comparing them with identification books and utilizing a determination key (Santri et al., 2021). Utilizing technology in the modern day can make the process of identifying and classifying more easier (Prasvita, 2012; Rifai et al, 2020). Based on the results of the literature review, there are three best practices using technologies that can be used to assist learning students, they are Plantnet, Picture This, and iNaturalist.

Previous studies have demonstrated the benefits of integrating technology and contextual learning for plant identification and classification (Wilsa et al., 2023). Besides that, it can use the Plantnet application to learn about biodiversity. PlantNet is an image-sharing and retrieval application for plant identification. Previous research by Joly, 2015 (Rifa et al., 2020) PlantNet is a plant identification and image capture application, it is simple to identify plant species that have detailed descriptions in the botanical database amount 20.000 plant species (Wilsa et al., 2023). Using this application, students find it helpful in identification and classification because they do not need to export images to Google, modules, or specialized websites to identify plants. This makes finding related information from other literature easier (Mu'minah et al., 2023). Besides that there's. The next application plant identifier is PictureThis. The purpose of this application is to locate plants that can provide comprehensive details about objects they have identified. This imaging program offers information up to the taxonomic level about these plants in addition to presenting scan results. The results of mosses, ferns, dicots, and monocots' identification recognize more than 1,000,000 different types of plants with 98% accuracy. PictureThis application can provide fairly complete taxonomic information for the various plant species tested (mosses, ferns, dicots, and monocots). The taxonomic information presented is also valid when compared to taxonomic information available in the literature and online searches (Wilsa et al., 2023).

The application of Naturalist can also be used as a best practice in biodiversity learning. Using the Naturalist platform, students can record their various experiences with biodiversity in today's world. Documentation of organisms can be saved in the form of photos, videos, and sounds. Besides that, this application identifies an organism and then records all the characteristics observed until guided to see the spread of the organism around the world on an ongoing basis supporting the local wisdom approach and environment approach (Pernat et al., 2022; Boone & Basille, 2019; Ramdani, 2018). The integration of this activity is a way to show the power of citizen science to gather biodiversity observations. The students could also see how their observations could be merged with data from academic institutions in the online repository of the GBIF. Additionally, iNaturalist gave them access to additional information like global distribution maps, phenology patterns, conservation status, or position in the taxonomical tree, and citizen– science platforms offer a great potential to add value to traditional field activities (Echeverria et al., 2021; Unger et al., 2020).

CONCLUSION

In studying biodiversity material, students are required to observe various species and ecosystems. In addition, learners must also be able to provide conservation proposals through

prediction and communication activities. The use of CoRes in narrowing down the material is necessary to teach students and strive to support the achievement of the goals of the 15th SDG point. Based on the results of the analysis of the findings, the pedagogical review of the approach used namely local wisdom, using the field trip method and discovery learning model, as well as the use of technology to assist students in identifying PlantNet, Picture This and iNaturalist, is considered effective to be implemented in learning biodiversity material.

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Student's scientific argumentation skills in biology: A gender-based analysis

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Article Info	ABSTRACT
	Scientific argumentation skill is important to develop in learning because it empowers students' way of thinking in forming new knowledge, stimulates activity, learns to solve problems, build socio-cultural activities through presentations and criticism, encourages students to express their thoughts, understand concepts more easily and get used to critical thinking and logical. This research aimed to determine the significance of differences between scientific argumentation skills based on gender. Research data was obtained from sample class data, namely class XI Science at Bustanul Mubtadiin Proppo Pamekasan High School with 22 students. Measurement of scientific argumentation skills based on gender using an essay writing test with a scientific argumentation rubric using the Osborne Argument Model. Aspects measured were based on the quality of rebuttal, data, collateral, support, refutation, or presence of conflicting claims. The hypothesis test used was an independent sample T-Test using the Jamovi Statistics program. This study reported that the scientific argumentation skills of male and female students were significantly different, which scientific argumentation skills of female students were higher than males. This research provided implications for students to be skilled in scientific argumentation, especially in biology.

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INTRODUCTION

Education is an effort to improve students' aspirations, skills, talents, and potential. Education can improve the skills of human resources in the 21st century by facilitating the need to respond to global demands. Education is carried out to create an active learning environment to

develop one's potential such as personality, intelligence, noble morals, and skills in society, nation, and state. BNSP overcomes this by changing learning from teacher-centered to student-centered (Sutopo, 2016). In addition to learning in the 21st century requires students to be able to think critically, collaboratively, and communicatively, scientific argumentation skills are skills that are also needed by students to be able to convey their thoughts through observation results that are analyzed both verbally and non-verbally (Widhi et al., 2021).

Scientific argumentation is the ability to formulate and evaluate arguments, which is widely recognized as the foundation of good thinking and is one of the goals of science education. Argumentation includes the process of developing, evaluating, and validating scientific knowledge as well as the process of collecting knowledge. The essence of scientific argument is the construction of a claim or assumption based on scientific evidence (Faize et al., 2018). Scientific argumentation skills are important to develop in learning because they can train students' way of thinking to form new knowledge, stimulate students' activeness, help students learn to solve problems, build socio-cultural activities through presentations and criticism, encourage students to express their thoughts, understand concepts more easily and train students to think critically and logically (Fatmawati et al., 2018). In order for students to have good argumentation skills, it is necessary to be supported by teachers who have good learning management skills (Ekanara et al., 2018), by determining learning strategies or models that aim to realize the development of students' scientific argumentation skills in biology learning to the maximum. Students can be said to have good scientific argumentation skills if they can present arguments that include argumentative components, namely: demands, data, guarantees, support, objections, and explanations. The more complete these components, the higher or better the student's argument (Ekanara et al., 2018). Using the argumentation patterns of claim, evidence, reasoning, and rebuttal can improve high argumentation skills in students (Indrawati et al., 2019).

The results of a survey conducted on December 5, 2023, for the 2023-2024 school year at SMA Bustanul Mubtadiin in grade XI students of SMA Bustanul Mubtadiin showed that biology learning still depended on the teacher using the lecture method, so that 88% of students were still passive in discussing, arguing, and describe conclusions independently from the material presented by the teacher during biology learning. Students tended to present their ideas without sufficient depth or critical analysis. Instead of engaging with evidence and drawing logical conclusions, their responses often relied on general statements or unsupported claims. This lack of rigor not only undermined the quality of their arguments but also reflected a limited understanding of the scientific method, where evidence had to support claims to be considered valid. So, they need to be directed by the teacher to conclude. The second observation on December 16, 2023, showed that there were 3 students and 10 female students who were active in asking and answering questions, but students still had difficulties in delivering arguments and answers scientifically. This fact showed that the scientific argumentation skills of grade XI students of Bustanul Mubtadiin High School still need to be developed. This was in line with the researcher's opinion who explained that the level of student argumentation, both verbally and in writing, is still weak and students have not been able to convey their analysis well (Anwar et al., 2019).

Gender is one of the influential aspects of students' argumentation skills. Research shows that there is a significant difference in scientific argumentation skills between male and female students, where female students' scientific argumentation skills are better than male students, both in terms of claims, evidence, and reasoning (Atqiya et al., 2020). Gender in Latin is called "Genus" which means type. Epistemologically, gender is the traits and behaviors associated with men and women due to social and cultural influences. In terminology, gender refers to the division of roles, functions, statuses and responsibilities given to men and women as an embedded form of culture. Gender is formed due to social and cultural influences, it is not permanent so it can change

according to time and place. Lippa stated that one of the differences between men and women lies in the sex chromosomes that cause differences in brain structure (Suendang, 2017). This difference in brain structure then determines the abilities of men and women which shows that in class discussions men often dominate the conversation while women do not. However, when there is a discussion in a smaller group, students who are not actively speaking will actively speak (Fitriyyah, 2021).

In the results of another study, it was found that scientific argumentation skills in female students were more active or tended to be meticulous in answering, and their symbolic ability was higher in answering questions or arguing than male students who relied more on verbal skills in arguing to answer questions or arguments (Sholihah, 2019). Based on the results of other studies, it was shown that the achievement of argumentation skills before and after learning there was an increase in students' argumentation skills. In the study, it was found that scientific arguments differ based on gender in students (Afgani et al., 2021).

The above statements show that scientific argumentation skills are an important aspect of 21st-century education, where there are aspects of communication, collaboration, and using information to solve complex problems (Suprapto et al., 2018). However, research reports that the quality of students' written arguments is still in the low category because classroom learning has not facilitated students in arguing. Students are not used to solving argumentative test questions because they are discussed directly or in writing (Rahayu et al., 2020). The empowerment of argumentation skills is important for students because, in addition to being scientific in learning concepts, students can also have the opportunity to practice confirming or refuting students' ideas (Hasnunidah et al., 2018). Scientific argumentation skills are an important aspect in improving students' science literacy skills (Chaerunisa et al., 2020) In addition, scientific argumentation skills can help students understand science, especially in biology subjects. Scientific argumentation skills are also a standard of competency for graduates, as stipulated in regulation No. 21: 2016 of Kementerian Pendidikan dan Kebudayaan (Nadifah, 2023).

Based on this, it is clear that scientific argumentation is very important in education so the author is interested in conducting research on the relationship of gender-based scientific argumentation skills in high school students based on Islamic boarding schools to find out if there are scientific argumentation skills based on gender in grade XI students of Bustanul Mubtadiin High School. Therefore, the researcher is interested in a study titled Scientific Argumentation Skills in Male and Female Students of Class XI of Bustanul Mubtadiin Proppo Pamekasan High School.

RESEARCH METHODS
Research Design

This study used quantitative research with a comparative. This comparative study aimed to determine the significance of differences in scientific argumentation skills based on gender in students.

Population and Samples

The samples used in this study were students of class XI IPA SMA Bustanul Mubtadiin Proppo Pamekasan with 22 students. Sampling was carried out using a random sampling technique, in which the population was divided into clusters, and the clusters were randomly selected as the sample.

Instruments

Measurement of scientific argumentation skills based on gender using an essay writing test with a scientific argumentation rubric using the Osborne Argument Model (Osborne et al., 2004).

Aspects measured were based on the quality of rebuttal, data, collateral, support, refutation, or presence of conflicting claims. The learning instruments used in this study included Syllabus, Lesson Plan, and Worksheet.

Procedures

The implementation time of this study began from February to May 2024, in the second semester in class XI IPA SMA Bustanul Mubtadiin Proppo Pamekasan in the academic year 2024/2025. This research utilized the guided inquiry learning model as a key approach to enhance scientific argumentation skills.

Data Analysis

Data analysis was conducted using the Jamovi statistic program. Before testing the research hypothesis, first the normality and homogeneity of data have been tested. The proposed research hypothesis was tested with an Independent Sample T-test with a significance level of 0.05 ($P<0.05$) using students' scientific argumentation skills data.

Descriptive data on scientific argumentation skills for 9 male students and 13 female students were presented in the form of descriptive statistics in Table 1. The average score of scientific argumentation showed that the average result of the final test of scientific argumentation skills of male students was 12.0 The average result of the median final test of scientific argumentation skills of female students was 15.0.

Table 1. Descriptive Data

	Group	N	Mean	Median	SD	SE
Argumentation	Male	13	10.6	12.0	5.99	1.66
	Female	9	16.9	15.0	7.99	2.66

RESULTS

The normality test is declared normally distributed if the significance is more than 0.05. Table 2 shows that the value is 0.015 which means ($P < 0.05$) which means it is not normally distributed, so the normality assumption test is not met. The summary of assumption test results in data normality assumption test results can be seen in Table 2.

Table 2. Normality Test (Shapiro-Wilk)

	W	P
Score	0.0883	0.014

The homogeneity assumption test is carried out before the hypothesis test. The results of the homogeneity test can be seen in Table 3, which shows that the residual data is homogeneously distributed, this is indicated by a significance value of 0.894 ($P <0.05$). Therefore, the assumption of homogeneity has been fulfilled.

Table 3. Homogeneity Test Results

	F	df	df2	p
Argumentation	0.0183	1	20	0.894

The results of the hypothesis test are based on the results of scientific argumentation data analysis. The results of the analysis based on the magnitude of the unpaired t-test can be seen in Table 4. The results of the independent samples T-Test hypothesis test showed that there was a

difference in the median score of scientific arguments in both genders using the Mann-Whitney test of (U=40.0, P= 0.226).

Table 4. Hypothesis Test Results

		Statistic	df	p
Argumentation	Student's t	-2.11	20.0	0.048
	Mann-Whitney U	40.0		0.226

DISCUSSION

The results of this study were in line with previous research that there was a significant difference in scientific argumentation skills in male and female students, where female students have better scientific argumentation skills than men. This is because female students tend to be conscientious, diligent, and willing to listen to explanations well (Pujiati et al., 2019). Other research results report that female students in every step of decision-making and conclusion are based on reasons in the form of words and tend to be detailed, complete, clear, and relevant, while male students in each step of decision-making and conclusion are based on reasons that tend to be short (Cahyono, 2017). The difference in scientific argumentation skills in male and female students is also due to the difference in mindset between men and women, where there are differences in certain indicators in the learning process, especially in the process of solving a problem (Hadi et al., 2021) and (Afifah et al., 2019). With different ways of solving problems, male students tend to use methods that they think are easier, but male students cannot apply methods or procedures properly and correctly, while female students tend to remember formulas, concepts, and procedures that have been taught. So female students tend to use the methods that have been explained by the teacher (Hariananda & Zainuddin., 2022).

In this study, the use of problem-based questions can determine the level of students' scientific thinking ability The problem-based questions used are related to events in daily life. Analysis through the process of reasoning in solving problems will train students' scientific argumentation skills so that problem-based question tests can be used to determine students' scientific argumentation skills (Afinadhita & Abadi, 2022). In this regard, female students provide better justifications for problems that are identified, more constructive, and of higher quality compared to male students (Noroozi et al., 2023).

Another difference was seen in hormones that also influenced the action between male and female students (Sabtri et al., 2018). The testosterone hormone in men makes them like to compete and enjoy challenges, while in women the hormones that have estrogen and progesterone make them more relaxed and peaceful and happy to gather to find information, therefore women tend to enjoy reading and reasoning (Amin, 2018). This causes the verbal ability of female students to be superior to that of male students. The concept of gender or gender can be reviewed from several theories, such as biological theories. In principle, gender according to biological theories is the development of sex which includes hormonal activity as well as individual behavior. Some studies say that men have high testosterone levels. In addition to hormonal influences, gender development can be reviewed from the use of the brain which will later affect their mindset. Male students tend to use their left brain so that they can think abstractly, logically, and analytically, while female students tend to use their right brain, as a result, they will be active linguistically, holisticly, imaginatively, perceptively thinking, and some visual abilities (Lestari, 2016). The results of this study are in line with previous research which states that biologically the brain shape of men and women is different which affects the way of thinking, and actions and affects the learning patterns of both (Amin, 2018).

In addition, environmental factors are one of the factors that affect students' intellectual abilities (Anggraini et al., 2018). Environmental factors influence students, where female students prefer quiet learning because the female brain contains more serotonin, so it tends to be calmer. In contrast to male students who prefer challenges and practicum learning that is carried out outside the classroom (Amin, 2018). The significance of the difference in scientific argumentation skills in male and female students does not reduce the importance of empowering these skills in learning, because in real life, argumentation skills are considered necessary to solve various life problems (Wikara et al., 2022). Empowerment of these skills can be done by applying recommended learning models, such as guided inquiry.

CONCLUSION

Scientific argumentation is a crucial skill for students, empowering them to formulate and evaluate arguments while serving as a foundation for strong critical thinking. This study revealed a significant difference in scientific argumentation skills based on students' gender, with female students demonstrating superior abilities compared to their male counterparts. Several factors influence this disparity, both internal and external. Internal factors include hormonal influences, individual behaviors, and aspects of gender development, which can be analyzed in terms of brain utilization. Additionally, external factors, such as the learning environment, play a significant role in shaping students' scientific argumentation skills. In particular, the application of appropriate learning models is essential for effectively enhancing these skills. Relevant learning models to empower students' scientific argumentation skills include guided inquiry, problem-based learning, and project-based learning. Future researchers need to consider the duration of the study and students' readiness to learn using the guided inquiry learning model.

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Microbiological quality analysis of grouper salted fish (Epinephelus Fuscoguttatus) in several traditional markets in ambon

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Article Info	ABSTRACT
	Salted fish is one of the food ingredients that is in demand by the community and has great potential in almost all traditional markets in Maluku, especially in the city of Ambon. One of the salted fish is grouper fish (*Epinephelus fuscoguttatus*) great potential, so it is necessary to conduct food safety checks from the microbiological aspect. This study aimed to analyze the total plate count of bacteria in grouper salted fish sold in several traditional markets in Ambon City, Indonesia. The research method used was quantitative descriptive with an experimental laboratory approach. The results of the total bacterial plate in the grouper salted fish sample from the Mardika market ranged from 1,55 x 103 CFU/mL to 1,05 x 104 CFU/mL, the origin of the Rumah Tiga market ranged from 3,85 x 103 to 3,5 x 104 and the origin of the Waiheru market ranged from 9,5 x 102 to 4,5 x 103 CFU/mL. In conclusion, the three samples of grouper salted fish do not exceed the maximum limit of the total plate count according to the Indonesian National Standard (INS) of 1x105 CFU/g so considered safe for consumption from a microbiological aspect.

INTRODUCTION

Geographically, Indonesia is the largest archipelago in the world and has considerable potential to be utilized optimally in the fisheries sector. Maluku Province has a sea area of 92.4%, with many islands including Ambon Island, which is one of the islands (Tuapetel et al, 2022). The coral reef ecosystem around Ambon Island is home to various marine animals, including reef fish. There are many types of reef fish found in the waters of Ambon Island, one of which is grouper (*Epinephelus fuscoguttatus*) which is an important food source and has economic value (Aznardi et al, 2020). Grouper fish is also easy to find in traditional markets in Ambon city. However, fish do tend to spoil easily compared to other foods (Jeujanan, 2022; Rini et al, 2020). To prevent

spoilage, fish products are processed and preserved. One of the methods of preservation of fish that is often used is salting. Fish that are decent, safe, and meet the requirements for cleanliness and health are fish that meet the Indonesian National Standard (INS) based on low microbial contamination levels (Nurliana et al, 2023).

Bacteria that are often found in fish are *Escherichia coli* and *Salmonella* sp. *Escherichia coli* generally lives in the digestive system of mammals, including humans (Sinaga et al, 2022). *E. coli* also often colonizes the surface of fish meat (Chotimah et al., 2023) and fishing water (Larawo et al., 2019). Other studies have shown that *Vibrio harveyi* was also found to contaminate grouper fish from the Maros cultivation center (Seniati et al., 2019). These bacteria can contaminate not only fresh fish but also other food sources and if they are contaminated and consumed, they will be very dangerous to the health of consumers because they can cause foodborne disease.

According to the World Health Organization (WHO), Each year worldwide, unsafe food causes 600 million cases of foodborne diseases and 420.000 deaths. 30% of foodborne deaths occur among children under 5 years of age. Food poisoning causes diarrhea and kills about 3 million children under the age of 5 every year (BPOM, 2015). Based on data obtained from the Food and Drug Supervisory Agency (BPOM), it shows that in 2009-2013 there were 10,700 cases of extraordinary food poisoning in Indonesia with 411,500 people getting sick and 2,500 people dying (BPOM, 2018). Therefore, it is necessary to carry out food safety inspections that are reviewed from the microbiological aspect.

In a study conducted by Hernanda et al (2023), which identified bacteria in salted fish sold at the market in the suburbs of Samarinda City, the results showed that all samples that had been studied were contaminated with bacteria. Another study was also conducted by Tuhumury (2022), which analyzed the total of *Salmonella* spp bacteria. In the samples of smoked skipjack fish products sold at the Mardika Market, there was contamination with *Salmonella* spp. bacteria, while the smoked skipjack fish samples taken at the Modern Market and the Small Hative Market, it was not contaminated or contaminated by *Salmonella* sp. However, in the city of Ambon itself, there is still no research that analyzes the total plate count of bacteria in grouper salted fish (*Epinephelus fuscoguttatus*) marketed in several traditional markets. Therefore, the current study aimed to analyze the total plate count of bacteria in grouper salted fish (*Epinephelus fuscoguttatus*) sold in several traditional markets in the City of Ambon.

RESEARCH METHODS
Research Design

The research was quantitative descriptive research using the true experimental laboratory approach method. The stages in this study were using serial dilution then isolated with spread plate technique, and analyzed the total plate count of bacteria in grouper salted fish (*Epinephelus fuscoguttatus*) sold in several traditional markets in the City of Ambon. The results of the total plate count were then compared with the Indonesian national standard (INS) 1×10^5 colony/g (BSNI, 2009).

Population and Samples

In this study, the samples used were grouper salted fish taken from 3 traditional markets in Ambon City, namely Mardika Market, Rumah Tiga Market, and Waiheru Market. There are 13 traditional markets in Ambon City, of which 8 markets are still active, while the other 5 markets are inactive or not operating. In 8 traditional markets that are still active, it was found that there were only 3 markets that sold grouper salted fish, so the sampling technique in this study used the purposive random sampling technique.

Instruments

The tools used in this study were autoclaves, incubators, stirrers, mortars, analytical scales, measuring cups, beaker glasses, pens, books, cameras, erlenmeyers, microscopes, vortex, ose needles, micropipettes, aluminum foils, petri dishes, test tubes, colony counters. Meanwhile, the ingredients were grouper salted fish, 0.85% NaCl solution, PCA media, Nutrient Agar (NA) media, gram staining reagents, and sterile aquadest.

Procedures
Sterilization of Tools and Materials

The tools and materials used such as petri dishes wrapped in paper, Erlenmeyer, and media covered with aluminum foil, test tubes, and glasses containing micropipettes were then sterilized in an autoclave at 121°C for 15 minutes.

Sample Preparation

Samples of grouper salted fish were taken from 3 traditional markets in the city of Ambon (Mardika Market, Rumah Tiga Market, and Waiheru Market). The sample was then cut into small pieces, then pounded until smooth using mortar.

Preparation of Plate Count agar

A total of 22.5 grams of plate count agar (PCA) media was mixed with sterile aquadest until it reached a volume of 1000 mL. The medium was further simmered on a hot plate until completely dissolved. The medium was then sterilized in an autoclave with a pressure of 1 atm (temperature 121°C), this process takes 15 minutes at a pressure of 1 atm. The media was then incubated for 24 hours and made sure there was no contamination before starting the isolation process.

Bacterial Isolation

Bacterial isolation was carried out by serial dilution. Five grams of fish samples were put into a test tube containing 45 mL of sterile distilled water as a pre-dilution and homogenized by vortex. Dilution 10^{-2} was performed by taking 1 ml of suspension from the first dilution, transferring it into a test tube containing 9 ml of aquades, and homogenizing. Then, dilute 10^{-3}, 10^{-4}, and 10^{-5} in the same way. Then, the PCA media was inoculated using the plate spread technique and incubated at a temperature of 37 °C for 24-72 hours.

Total Plate Count Analysis

The number of bacterial colonies that grow per petri dish was then counted on each petri dish. Calculation of the number of bacterial colonies to find out the total plate count of bacteria in 1 mL of sample, by the following formula (Yunita et al., 2022a; Yunita et al., 2022b):
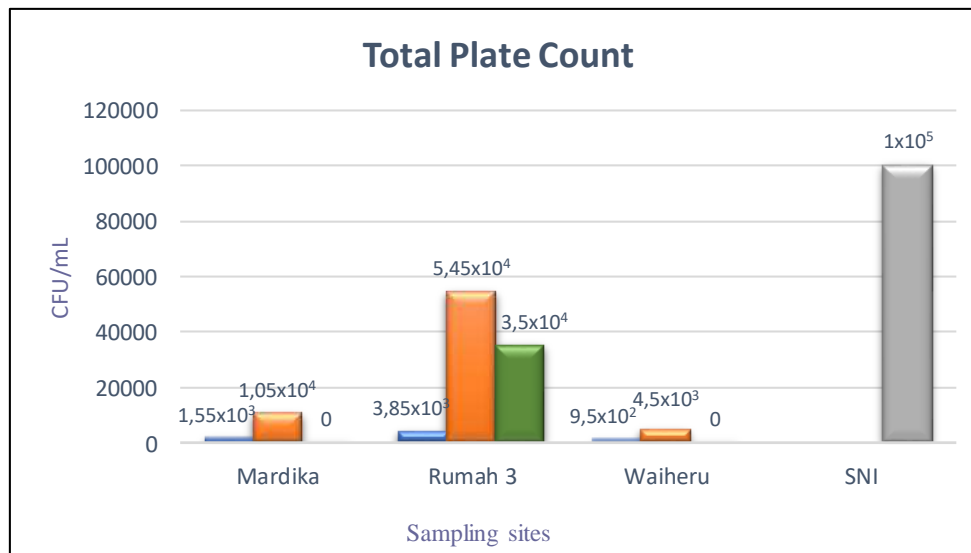
$$\text{Total Plate Count} = \text{number of bacterial colonies} \times \frac{1}{\text{dilution}}$$

RESULTS

The results of the analysis of the Total Plate Count are presented in Table 1, where in the salted fish sample from the Mardika market the number of colonies at dilution 10^{-1} was 1.55×10^3 CFU/mL, then dilution 10^{-2} was 1.05×10^4 CFU/mL. In the salted fish sample from the Rumah Tiga market, the number of colonies at the 10^{-1} dilution was 3.85×10^3 CFU/mL, the 10^{-2} dilution was 5.45×10^4 CFU/mL, and the 10^{-2} dilution was 3.5×10^4 CFU/mL with. In the salted fish sample from the Waiheru market, the number of colonies at 10^{-1} dilution was 9.5×10^2 CFU/mL, and at 10^{-2} dilution was 4.5×10^3. The comparison of total plate count and INS is presented in Figure 1.

Table 1. Results of Total Plate Count Analysis of Grouper Salted Fish (*E. fuscoguttatus*)

No.	Traditional Market	Total Plate Count (CFU/mL)			INS
		10^{-1}	10^{-2}	10^{-3}	
1.	Mardika	$1.55 \times 10^3 \pm 7$	$1.05 \times 10^4 \pm 21$	0	1×10^5
2.	Rumah Tiga	$3.85 \times 10^3 \pm 35$	$5.45 \times 10^4 \pm 7$	$3.5 \times 10^4 \pm 21$	1×10^5
3.	Waiheru	$9.5 \times 10^2 \pm 21$	$4.5 \times 10^3 \pm 7$	0	1×10^5

Figure 1. Comparison Chart of Total Plate Count of Grouper Salted Fish (*E. fuscoguttatus*)

DISCUSSION

According to the study, the total count from the three samples of grouper salted fish examined has several bacterial colonies below Indonesian National Standards (INS) and is suitable for marketing and consumption. In a study conducted by Sukmawati (2022) which analyzed the total plate count of salted anchovy microbes at the Remu Market, Sorong City, West Papua, the results were that of the nine salted fish samples tested, all of them were below the INS standard so that they were still suitable for consumption. The salted fish samples used in the study were in an open condition starting from the production process to distribution.

Another study was also conducted by Huda (2022) which analyzed the Total Plate Count of Terasak Fish (*Escualosa thoracata*) Salting Dry Household Industry in the District Lekok Pasuruan Regency obtained the results that of the 6 salted fish samples examined, 4 samples met the INS standard requirements, while the other 2 samples did not meet the INS standard. This can be because the samples taken from the three markets use clean plastic packaging. This is by research conducted by Nurhasanah et al. (2022), which said that packaging has an important role in preventing or reducing damage to a product to be packaged, especially food products. In addition, the effect of preservation using salt affects the growth of bacteria.

According to Ahillah et al. (2017), said that salt has a high enough osmotic pressure that causes osmotic processes in the body of fish and plasmolytic processes in microorganism cells. These processes can inhibit the growth of bacteria. This is also to the understanding of Muhammad et al. (2019), where salt can reduce microbial activity in salted fish products because the salting and drying processes reduce and replace moisture and free water in salted fish products. Microorganisms and bacteria are also inhibited by desiccation, which reduces moisture content and inhibits microbial and enzyme activity.

The total amount of bacteria in the grouper salted fish samples sold at the Rumah Tiga market is suspected to be due to the length of storage compared to the other 2 samples. This is in line with research conducted by Ruksanan (2020), which showed that the length of storage affects the total microbes of dried salted cepa fish produced. Although the Rumah Tiga market is relatively empty of visitors and vehicles and is quite clean, it is possible that the food sold can be contaminated with bacteria. The processing process also affects bacterial contamination such as the hygiene of processors who do not pay attention to hand hygiene and the equipment used when processing salted fish. The drying process by drying in the sun can also be contaminated with various dust, dirt, and even flies that can land on the salted fish. This is also in line with research conducted by Nasution (2020), which said that the main sources of contamination in food come from food handlers or workers, garbage, equipment, rats, insects, and environmental factors such as air and water. Of all the sources of food contamination, food handlers are the most affected by contamination. The health and hygiene of food processors have a considerable influence on the quality of the products they produce, so they need attention.

According to the study findings, salted fish sold in an open condition does not necessarily cross the safe limit according to Indonesian national standards. Thus, the biggest contamination factor in salted fish is during the production process where contamination can come from the environment food handlers, and unclean equipment during the production process (Sipriyadi et al., 2022).

CONCLUSION

Grouper salted fish sold in three traditional markets in Ambon City, namely Mardika market, Rumah Tiga market, and Waiheru market are considered safe for consumption from a microbiological perspective with a total plate count of bacteria in the sample of grouper salted fish from Mardika market ranged from 1.55×10^2 to 1.05×10^4, from the Rumah Tiga market ranged from 3.85×10^3 to 3.5×10^4 and from Waiheru market ranged from 9.5×10^2 to 4.5×10^3. Therefore, this study implies that Grouper salted fish sold in several traditional markets in Ambon City, namely Mardika market, Rumah Tiga market, and Waiheru market are considered safe for consumption from a microbiological aspect thus people do not need to worry about buying and consuming grouper salted fish sold in traditional markets because they have been tested for safety according to INS.

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Development of multiple-representation based E-LKPD to improve students' scientific reasoning in classification of living things

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Article Info	ABSTRACT
	Scientific reasoning is a 21st-century skill that needs to be trained to prepare students to face the challenges of globalization. This can be supported by developing e-LKPD (electronic student worksheets) based on multiple representations. This research aims to determine the validity, practicality, and effectiveness of e-LKPD. This type of research is development research that applies the ADDIE model. The validation results by three experts had an average score of 81.66, 86.4, and 85.33 with a very valid category. Practical results were obtained based on student response questionnaires and observations of learning implementation. On a small scale at SMPN 2 Tanggul it was 78 (practical) and observation results were 87.11 (very practical), while on a class scale at SMPN 1 Wonosari, the student response questionnaire score was 81.28 (very practical) and observation results were 84.10 (very practical) practical), SMPN 1 Arjasa with a questionnaire response was 78.9 (practical) and observation results were 86.12 (very practical), MTsN 3 Banyuwangi was 87.72 (very practical) and observation results were 89.23 (very practical).

INTRODUCTION

Education cannot be separated from a systematic learning process. Learning is a process of interaction between educators and students and learning resources that are applied in a learning environment (Abroto et al., 2021). Science learning is not just mastery of knowledge in the form of facts or concepts but is a process of discovery (Nupita, 2013). The science learning process

emphasizes direct experience for students to make it easier to understand the natural environment scientifically (Primayana et al., 2019). Science learning is concept learning that requires strong reasoning and mental processes in students. Students in Indonesia are relatively unable to apply scientific knowledge to face challenges in real life (Wisudawati & Sulistyowati, 2022).

Scientific reasoning is the ability to conclude based on existing evidence. Scientific reasoning is a cognitive skill in evaluating and understanding scientific information (Azmi et al., 2020). Scientific reasoning abilities compiled based on the Lawson Classroom Test of Scientific Reasoning (LCTSR) include six indicators including conservation reasoning, proportional reasoning, variable control, probability reasoning, correlational reasoning, and deductive hypothesis reasoning (Mandella et al., 2021). Students who have good scientific reasoning skills will easily understand conceptual material in learning (Azmi et al., 2020).

Scientific reasoning is one of the abilities tested in the Program for International Student Assessment (PISA) at the junior high school level according to the Organization for Economic Cooperation and Development (Schleicher, 2019). However, in Indonesia, students' scientific reasoning is still relatively low. Indonesia's science score is 396, very far below the international average science score of 489. Indonesia is ranked 70th out of 78 other participating countries (Wilujeng & Wibowo, 2021). Based on these data, there needs to be an improvement in the scientific reasoning of Indonesian students (Balqis et al., 2019). Scientific reasoning is very important to practice because it is the basis of the discovery process and builds skills such as problem-solving and higher-level thinking (Handayani et al., 2020). Scientific reasoning is a 21st-century skill that needs to be trained, it aims to prepare students to face the challenges of globalization (Khumaira, 2023).

LKPD is one of the learning media that can be developed by educators and designed according to the situation and conditions of the learning activities faced (Martine, 2020). LKPD contains student guides for carrying out activities and requires students to be more active in the learning process and competency development (Subakti et al., 2021). Therefore, the use of LKPD in the learning process can improve the expected implementation process. The LKPD that is often used in schools is not clear, has no color, and is not accompanied by pictorial representation. This makes students less interested and easily bored in using LKPD. Multiple-representation based LKPD can support understanding (Indah & Wahyuni, 2022).

Multiple-representation means re-representing the same concept in different forms and ways (Silaban et al., 2022). The forms and methods referred to are verbal, mathematical, pictorial, and graphic. There are three main functions of multiple representations, namely as a complement, overcoming obstacles to interpretation, and deepening understanding (Mahardika, 2012). There are several reasons why it is important to use multiple representations, including multi-intelligence, visualization for the brain, and helping construct representations (Dudeliany et al., 2021). Multiple-representations can emphasize understanding of concepts because more than one representation is presented. This can be implemented using multi-representation based LKPD (Indah & Wahyuni, 2022).

Adapting to the rapid development of science and technological developments, the presentation of LKPD starts from sheets of paper and can then be operated on electronic devices (Dewi & Agustika, 2022). Electronic Student Worksheets (e-LKPD) can make it easier for teachers and students to carry out effective and efficient learning (Suryaningsih & Nurlita, 2021). The e-LKPD contains text, images, videos, or navigation that can be controlled by students which are not contained in conventional LKPD so that the e-LKPD can support the learning process with different learning styles and thinking speeds of students (Setiana & Nuryadi, 2021). The use of e-LKPD in science learning can be applied to material on the classification of living things and can help teachers strengthen students' understanding (Setyawati, 2023).

Classification material for living things has complex characteristics for each phylum and class, as well as many scientific names, making it difficult for students to understand (Kurniawan & Hasanah, 2022). This material is classified as material that is difficult to learn because students are required to understand the concept of classification of living things (Ratnawati et al., 2020). To overcome this, teachers can develop e-LKPD which helps students to develop their abilities in understanding concepts and gaining a broader understanding (Dewi & Agustika, 2022). Based on these problems, researchers want to know the validity of multiple-representation based e-LKPD to improve students' scientific reasoning on the material on the classification of living things.

This research offers novelty in the development of an e-LKPD based on multiple representations to enhance students' scientific reasoning skills in the topic of the classification of living organisms. Unlike previous studies, which generally focused only on the development of conventional LKPD or those based on a single type of representation, this research integrates various forms of representation (verbal, visual, table, and graphical) into an electronic platform. Previous studies, such as those conducted by Subakti et al., 2021, only developed LKPD in printed format or focused solely on visual representation. Additionally, this research also aims to improve students' scientific reasoning skills, which has not been the primary focus in many previous studies, particularly on the topic of the classification of living organisms. The multiple-representations based e-LKPD is not only intended to enhance conceptual understanding but also to improve students' scientific reasoning skills, which are crucial for science education. Therefore, the development of this multiple-representations based e-LKPD provides a new contribution to the field of digital learning media development, making it more interactive and integrated.

RESEARCH METHODS
Research Design

The type of research used in this research was development research. Development research is research that will obtain new products from certain products that have been developed. The new products obtained will be tested for their effectiveness in people's lives, thus the resulting products are expected to be useful both now and in the future (Sugiyono, 2009). This product development research applies the ADDIE model. is composed of five stages, namely Analysis, Design, Development, Implementation, and Evaluation. The research development design can be seen in Figure 1.
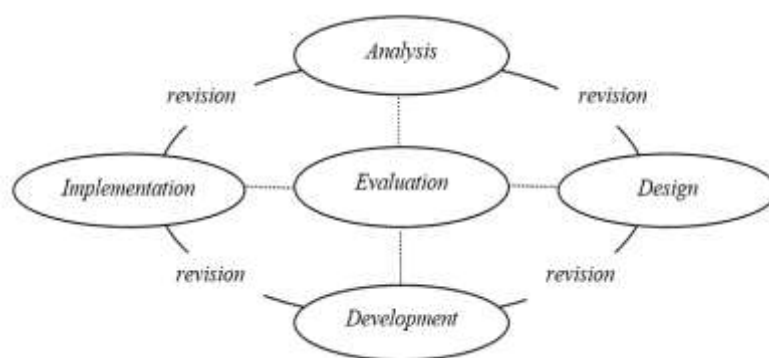
Figure 1. Research Design for the Development of e-LKPD Based on Multirepresentation

Population and Samples

The subjects of the study were (1) two science lecturers and one biology education lecturer from the Faculty of Teacher Training and Education as validators (2) four science teachers from each school, namely SMPN 1 Tanggul, SMPN 1 Wonosari, SMPN 1 Arjasa, and MTsN 3 Banyuwangi (3) 9 students from SMPN 2 Tanggul, 32 students from SMPN 1 Wonosari, 31

students from SMPN 1 Arjasa, and 32 students from MTsN3 Banyuwangi. The object of the study was e-LKPD based on multi-representation of the material classification of living things.

Instruments

The instruments used in this research include validation, a student response questionnaire, and pre-test and post-test results. Validation was obtained based on the scores from expert lecturers, namely experts in content, media, and development, to determine the validity of the multiple-representations based e-LKPD. The student response questionnaire aims to collect data regarding the practicality of the multiple-representations based e-LKPD. The initial pre-test and post-test aim to determine the extent to which the e-LKPD can improve students' scientific reasoning skills. The tests used consist of 6 initial test questions and 6 final test questions according to the scientific reasoning indicators based on Lawson's Classroom Test of Scientific Reasoning (LCTSR). An explanation of scientific reasoning indicators is shown in Table 1.

Table I. Indicators Scientific Reasoning

Scientific Reasoning Skill	Indicator
Conservational Reasoning	The ability to maintain an understanding or knowledge even when the appearance of an object changes.
Correlational Reasoning	The ability to think correlationally in determining whether two events or two variables are related or not.
Probabilistic Reasoning	The ability to think probabilistically as a situation where a specific answer is produced when repeated under the same conditions in different contexts.
Proportional Reasoning	The ability to provide answers based on the possible outcomes of an event.
Control of Variable	The ability to identify or control the variables of an existing problem.
Hypothetical-Deductive Reasoning	Hypothetical reasoning is the ability to test a hypothesis, while deductive reasoning is the ability to conclude. Therefore, hypothesis-deductive reasoning is the ability to conclude by first testing a hypothesis.

Based on the scientific reasoning indicators above, the following is an example of a grid of questions adapted to Lawson's Classroom Test of Scientific Reasoning (LCTSR). An example of the question grid can be seen in Table 2.

Procedures

Multi-representation based E-LKPD was developed using the ADDIE development model. The ADDIE development model includes 4 stages, namely Analysis, Design, Developmen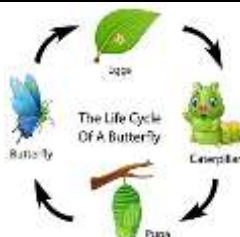t, Implementation, and Evaluation. At the analysis stage, needs analysis and determination of materials to be developed in e-LKPD are carried out. Determination of materials is the initial step in development. The materials developed in this e-LKPD are the classification of living things. This design stage is the product design stage carried out to produce an initial product draft which includes a cover, foreword, table of contents, learning activities, and a bibliography. The development stage is the stage of assessing the feasibility of the product developed by material experts, media experts, and development experts. The purpose of validation is to obtain input and evaluation of the product that has been prepared for revision. The implementation stage is the stage for applying the e-LKPD product that has been prepared in real situations in the classroom so that the learning objectives that have been designed can be achieved. The evaluation stage is the final stage of the ADDIE model. This stage is to assess the quality of the product and the teaching

process. Determining evaluation criteria, selecting the right evaluation tools, and implementing evaluations are general procedures related to the evaluation stage.

Table 2. Grid of Questions

Reasoning Indicators	Question Indicators	Question	Cognitive Level	Answer
Conservational Reasoning	Students can analyze images of invertebrate animal groups	Analyze the image above. What group of animals does it belong to, and what characteristics indicate this?	C4	The image belongs to the group of invertebrate animals, with the following characteristics: • The animal's body structure is made of an exoskeleton. • The excretory organs in lower invertebrates have not been found. • The nervous system of invertebrates is still simple. • Invertebrates reproduce generatively and/or vegetatively. • The circulatory system of invertebrates is open.
Corelational Reasoning	Students are able to relate the life cycle of invertebrate animals to an images	Draw the life cycle of a butterfly and explain the relationship between each phase!	C5	 **Egg:** The female butterfly lays eggs on the surface of a leaf. **Caterpillar:** The egg hatches into a caterpillar, which eats actively and grows. **Pupa:** The caterpillar transforms into a pupa, where metamorphosis takes place inside. **Butterfly:** The chrysalis opens, and a butterfly emerges, ready to reproduce and begin the cycle again.

Data Analysis

Based on the validity formula above, the following are the validation assessment criteria which can be seen in Table 3. The data analysis used is qualitative analysis and quantitative analysis. The data analysis used is validity analysis, practicality, and effectiveness. Determine the validity value with the following formula:

$$V = \frac{\text{Total Score}}{\text{Max score}} \times 100\%$$

Table 3. Validation Assessment Criteria(Octaviara & Pahlevi, 2019).

Score range	Category
81% -100%	Very valid
61% - 80%	Valid
41% - 60%	Quite valid
21% - 40%	Less valid
0 – 20%	Not valid

Based on the practicality formula above, the following are the practicality criteria which can be seen in Table 4. In the practicality test measured in this research is the implementation of learning using observation sheets filled in by observers. Determine the practicality value using the following formula:

$$V = \frac{\text{Total Score}}{\text{Max score}} \times 100\%$$

Table 4. Practical Criteria for e-LKPD (Hidayat & Irawan, 2017).

Score range	Category
81% -100%	Very practical
61% - 80%	Practical
41% - 60%	Quite practical
21% - 40%	Not practical
0 – 20%	Not practical

In testing the effectiveness of multiple-representation based e-LKPD to improve students' scientific reasoning, it can be seen from students' learning results in the cognitive domain in the form of pre-test and post-test scores. The purpose of measuring student learning outcomes is to determine the achievement of planned learning objectives. Measuring the effectiveness of students' cognitive learning outcomes can be measured based on Normalized gain (g) with the formula according to Hake (1998). The value scale used for Normalized gain (g) data will be categorized in Table 5.

$$V = \frac{\text{Posttest score} - \text{Pretest score}}{\text{Max score} - \text{Pretest score}}$$

Table 5. Criteria for Normalized gain (g) (Hake, 1998).

No.	Gain score(g)	Criteria
1	$g \geq 0.7$	Tall
2	$0.3 \leq g < 0.7$	Currently
3	$g < 0.3$	Low

RESULTS

This product development research applies the ADDIE model, which is composed of five stages, namely Analysis, Design, Development, Implementation, and Evaluation.

a. Analysis

Problem identification aims to find out problems that arise in the learning process. This activity is carried out by distributing questionnaires in the form of a Google form to students and teachers. Distributing this Google form to 20 science teachers and 185 students in several schools in East Java. The results of distributing the questionnaire in the form of a Google form to students and teachers can be seen in Table 6.

Table 6. Teacher Needs Analysis Questionnaire Results

Statement	Teacher's Answer	Percentage (%)
Obstacles to teaching science concepts in classroom learning	Students are less interested in learning science	61.5
	Difficult to apply abstract material	27
	Less than optimal in applying learning methods	11.5
Characteristics of LKPD applied in class	Paper-based LKPD	76.9
	e-LKPD	23.1
LKPD applied in learning can help students understand the material	Yes	30.8
	Not helpful	69.2
Teachers have designed e-LKPD based on multiple representations in the learning process	Yes	19.2
	Never	80.8
Student responses to material on the classification of living things in class	Students are confused because the material is abstract	42.3
	Students are less interested in the material on the classification of living things	42.3
	Students are happy with the material on the classification of living things	20.4

Based on Table 5, shows that the results of respondents from 20 junior high school science teachers in East Java experienced problems in teaching science concepts because students were less interested in learning science with a percentage of 61.5%, 27% had difficulty applying abstract material, and 11.5% lacked optimal in applying learning methods. Furthermore, 76.9% of the LKPD implemented in class are paper-based and 23.1% are in electronic form. 69.2% of the LKPD applied did not help students understand the material. 80.8% of teachers have never designed a multiple-representation based e-LKPD and only 19.2% of teachers have ever designed an e-LKPD. From the results of the questionnaire, students were confused and less interested in the material on the classification of living things with the same percentage, namely 42.3%, while 20.4% of students were happy with the material.

Verbal representation   Image representation   Graphic representation   Table representation
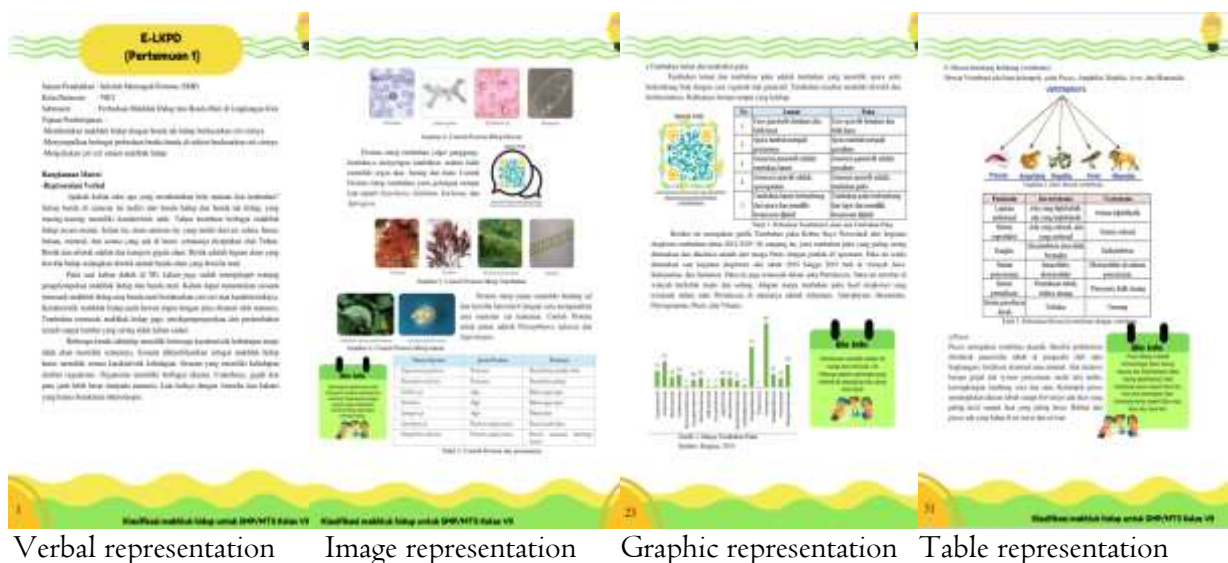
Figure 2. Multiple-representation based e-LKPD Design

b. Design

The design stage in this research was carried out through the preparation of a multiple-representation based e-LKPD on the material for the classification of living things, consisting of the preparation of the e-LKPD content framework, media selection, and preparation of tests. The results of the multiple-representation based e-LKPD design are presented in Figure 2.

c. Development

The expert validation test aims to obtain criticism, suggestions, input, and assessment of the multiple-representation based e-LKPD draft that has been prepared. Implementation of validation activities includes validation of e-LKPD and validation of learning tools. Validation activities were carried out by three expert validators and four users.

Multiple-representation based E-LKPD Validation Results

The multiple-representation based e-LKPD validation assessment was carried out by three expert validators, namely science education and biology education lecturers (material, media and development experts). This validation activity aims to measure the validity of the e-LKPD developed before the field trial process is carried out. Data from validation results by expert validators can be seen in Table 7.

Table 7. Multiple-representation based e-LKPD validation data

Evaluation	Score					
Expert Validator	Material	Criteria	Media	Criteria	Development	Criteria
Validator 1	83.33	Very Valid	86.4	Very Valid	82	Very Valid
Validator 2	73.33	Valid	84	Very Valid	85	Very Valid
Validator 3	88.33	Very Valid	88.8	Very Valid	89	Very Valid
Average	81.66	Very Valid	86.4	Very Valid	85.33	Very Valid

Based on Table 7, it can be seen that the average obtained from the three validators' assessment results was 81.6 in the material assessment with very valid criteria, 86.4 in the media assessment with very valid criteria, and the development assessment was 85.33 in the very valid category. This shows that the multiple-representation based e-LKPD has been declared valid in terms of material, media and development and can be continued at the validation stage by users. Validation of multiple-representation based e-LKPD by users was carried out on four users, namely class VII science teachers from the school which was carried out as a research site. Data from validation results by users can be seen in Table 8.

Table 8. User Validation Results Data

Validator	Score	Criteria
User 1	90.4	Very Valid
User 2	83.2	Very Valid
User 3	86.4	Very Valid
User 4	90.4	Very Valid
Average	87.6	Very Valid

Based on Table 8, it can be seen that the validation results by users show an average multiple-representation based e-LKPD score were 87.6 with very valid criteria. The results of this validation indicate that the multiple-representation based e-LKPD has been declared valid and can be tested on a small-scale trial to determine its practicality and effectiveness. The small-scale trial in

class VII C of SMPN 2 Tanggul consisted of 9 students with details of 3 students with high cognitive abilities, 3 students with medium cognitive abilities, and 3 students with low cognitive abilities. The results of small-scale trials are described below.

Student Response Questionnaire Results

Measuring the practicality of multiple-representation based e-LKPD is determined by the results of student response questionnaires. This response questionnaire aims to determine students' responses after reading and studying the e-LKPD. Student response questionnaires were given to 9 students of class VII C SMPN 2 Tanggul. The results of the student response questionnaire in the small-scale trial can be seen in Table 9.

Table 9. Results of Student Response Questionnaires on Small-Scale Trials

Trials	Average Questionnaire Results	Criteria
Small Scale (VII C)	78	Practical

Based on Table 9, it can be seen that the average student response questionnaire score for multiple-representation based e-LKPD on the overall classification of living things is 78 with practical criteria. This shows that students responded well to the multiple-representation based e-LKPD that had been developed.

Student Pre-test and Post-test Results

The assessment of students' scientific reasoning abilities was obtained from the results of the average pre-test and post-test scores carried out in four meetings in class VII C at SMPN 2 Tanggul. Data from the pre-test and post-test scores on students' scientific reasoning abilities can be seen in Figure 3.
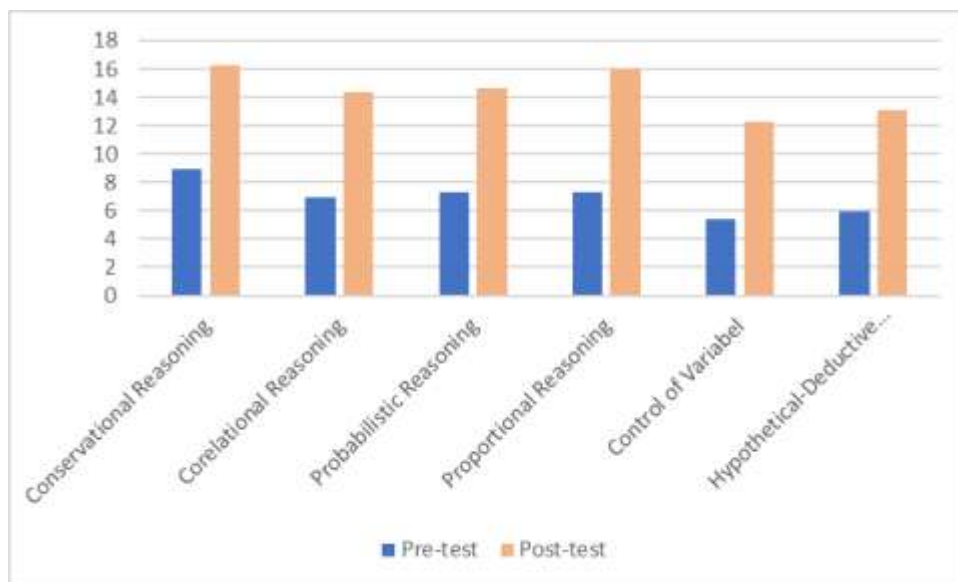

Figure 3. Average Small-Scale Scientific Reasoning Score

Based on Figure 3, it can be seen that the scores of 9 students in small-scale trials in class VII C of SMPN 2 Tanggul during four meetings with conservation reasoning mean pre-test was 8.97 and post-test was 16.25. The second indicator is correlation reasoning with a pre-test was 6.94 and a post-test was 14.36. The third indicator is probabilistic reasoning which has a pre-test value was 7.28 and a post-test of 14.61. The fourth indicator is proportional reasoning with a pre-test of 7.33 and a post-test of 16. The fifth indicator is variable control with a pre-test value was

5.42 and a post-test was 12.25. The sixth indicator is deductive hypothesis reasoning with a pre-test score was 5.95 and post-test 13.11. The mean of each indicator in the pre-test value is 6.98 and the post-test value is 14.43. The results of N-Gain in the four meetings that have been held can be seen in Figure 4.
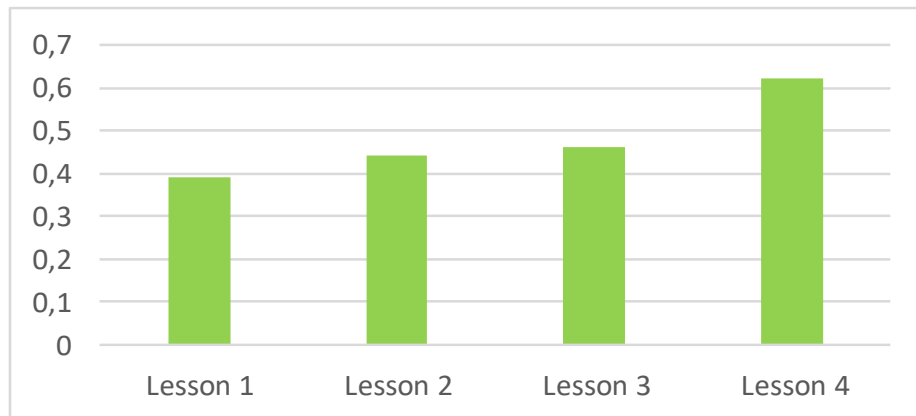

Figure 4. N-Gain Results of Small-Scale Trials

Based on Figure 5, it shows that there has been an increase in the average score at each meeting. The Normalized Gain (N-Gain) measurements carried out showed that at meeting one the N-Gain score was 0.39 with medium criteria. At meeting two it showed an increase to 0.44 with moderate criteria. Meeting three with N-Gain 0.46 and meeting four with 0.62 have medium criteria. This shows that multiple-representation based e-LKPD is effective in improving students' scientific reasoning abilities so that it can be continued in class-scale trials.

Learning Implementation Observation Results

Learning implementation observation sheets were given to three observers whose aim was to observe learning implementation while using multiple-representation based e-LKPD. The results of observations of learning implementation in small-scale trials can be seen in Table 10.

Table 10. Observation Results of Learning Implementation in Small-Scale Trials

Meeting	Observer Value (%)			Average Value	Criteria
	Observer 1	Observer 2	Observer 3		
1	66.20	66.20	70.77	67.69	Practical
2	70.76	80.7	81.53	77.66	Practical
3	80	81.53	83.07	81.5	Very Practical
4	87.6	87.6	86.20	87.11	Very Practical

Based on Table 8, it can be seen that the implementation of learning using multiple-representation based e-LKPD at meetings one and two obtained practical results, namely with an average of 67.69, and 77.66. At meetings 3 and 4 the average was 81.5 and 87.11 with very practical criteria. The improved e-LKPD will then enter the Implementation stage and will be tested on a class scale to measure the practicality and effectiveness of multiple-representation based e-LKPD.

d. Implementation

This multiple-representation based e-LKPD implementation stage was carried out in three schools, namely SMPN 1 Wonosari, SMPN 1 Arjasa, and MTsN 3 Banyuwangi during four meetings on the material of classification of living things.

Student Response Questionnaire Results

Giving student response questionnaires aims to determine the practicality of multi-representation-based e-LKPD. Filling out the student response questionnaire is done via Google Form. The results of the student response questionnaire regarding the use of multi-representation-based e-LKPD are in Table 11.

Table 11. Results of Student Response Questionnaire on Class Scale Trial

School	Average Questionnaire Results	Criteria
SMPN 1 Wonosari	81.28	Very Practical
SMPN 1 Arjasa	78.9	Practical
MTsN 3 Banyuwangi	87.72	Very Practical

Based on Table 11, it can be seen that the average score of the student response questionnaire to multiple-representation based e-LKPD on the material of classification of living things at SMPN 1 Wonosari with 32 students is 81.28 with very practical criteria, SMPN 1 Arjasa with 31 students and the results of the research a score of 78.9 has practical criteria, and MTsN 3 Banyuwangi with 32 students has an average questionnaire response result of 87.72 with very practical criteria. These results show that students gave a positive response to e-LKPD based on multiple representations of material on the classification of living things.

Student Pre-test and Post-test Results

The assessment of students' scientific reasoning abilities was obtained from the results of the average pre-test and post-test scores conducted four times in class VII A of SMPN 1 Wonosari with 32 students, class VII F of SMPN 1 Arjasa with 31 students, and in-class VII E MTsN 3 Banyuwangi as many as 32 students. The results of the pre-test and post-test scores based on indicators of students' scientific reasoning abilities carried out four times can be seen in Table 12.

Table 12. Class Scale Trial Results

No.	Scientific Reasoning Indicators	Average					
		SMPN 1 Wonosari		SMPN 1 Arjasa		MTsN 3 Banyuwangi	
		Pre-test	Pre-test	Pre-test	Post-test	Pre-test	Post-test
1.	Conservation Reasoning	5.64	15.59	6.2	16.27	5.48	18.14
2.	Correlational Reasoning	4.39	12.7	6.71	15.55	5.87	17.88
3.	Probabilistic Reasoning	4.37	13.94	6.01	15.67	5.07	18.01
4.	Proportional Reasoning	6.13	15.93	6.1	11.84	5.27	18.68
5.	Variable Control	4.85	14.71	5.59	15.67	4.76	18.32
6.	Deductive Hypothetical Reasoning	4.86	12.99	5.16	13.89	4.37	18.02
Average		5.04	14.31	5.96	14.82	5.14	18.18

Based on Table 12, it can be seen that students' scientific reasoning scores are known through the average pre-test and post-test scores of three schools, namely SMPN 1 Wonosari, SMPN 1 Arjasa, and MTsN 3 Banyuwangi. At SMPN 1 Wonosari with a pre-test score of 5.04 and a post-test score of 14.31. The second school, namely SMPN 1 Arjasa, has an average pre-test score of 5.96 and a post-test score of 14.82. The third school is MTsN 3 Banyuwangi with an average pre-test score of 5.14 and a post-test score of 18.18. The N-Gain results in four meetings at the three schools can be seen in Table 13.

Table 13. N-Gain Class Scale Trial Results

Meeting	SMPN 1 Wonosari		SMPN 1 Arjasa		MTsN 3 Banyuwangi	
	N-Gain	Criteria	N-Gain	Criteria	N-Gain	Criteria
1	0.43	Currently	0.49	Currently	0.61	Currently
2	0.47	Currently	0.52	Currently	0.7	Currently
3	0.51	Currently	0.54	Currently	0.72	Tall
4	0.55	Currently	0.6	Currently	0.74	Tall
Average	0.49	Currently	0.54	Currently	0.69	Currently

Based on Table 13, it shows that there was an increase in the average score at each meeting at SMPN 1 Wonosari, SMPN 1 Arjasa, and MTsN 3 Banyuwangi. The N-Gain results at SMPN 1 Wonosari from meetings one to four were respectively 0.43, 0.47, 0.51 and 0.55. The average N-Gain from the four meetings was 0.49 with medium criteria. The second school, namely SMPN 1 Arjasa, had N-Gain results from meetings one to four consecutively, namely 0.49, 0.52, 0.54 and 0.6. The average N-Gain result for the four meetings was 0.54 with medium criteria. The next school is MTsN 3 Banyuwangi with the N-Gain values for meetings one to four respectively being 0.61, 0.7, 0.72, and 0.74. The average of the N-Gain value is 0.69 with medium criteria. These results show that based of multiple-representation e-LKPD is effective in improving students' scientific reasoning abilities as seen through the results of the pre-test and post-test.

Learning Implementation Observation Results

Learning implementation observation sheets were given to three observers whose aim was to observe learning implementation while using multi-representation-based e-LKPD during four meetings at SMPN 1 Wonosari, SMPN 1 Arjasa, and MTsN 3 Banyuwangi. The results of observations of learning implementation in class scale trials can be seen in Table 14.

Table 14. Observation Results of Learning Implementation in Class Scale Trials

Meeting	SMPN 1 Wonosari		SMPN 1 Arjasa		MTsN 3 Banyuwangi	
	Average Value	Criteria	Average Value	Criteria	Average Value	Criteria
1	72.81	Practical	78.76	Practical	81.53	Very Practical
2	76.41	Practical	81.53	Very Practical	83.58	Very Practical
3	81.53	Very Practical	83.07	Very Practical	86.66	Very Practical
4	84.10	Very Practical	86.12	Very Practical	89.23	Very Practical

Based on Table 14, it can be seen that the average observation value of learning implementation from the first meeting to the fourth meeting has practical and very practical criteria.

e. Evaluation

The evaluation stage aims to determine whether the e-LKPD based on multi-representation material on the classification of living things for the learning process can be said to be valid, practical, and effective. This evaluation stage does not occur at all stages, but only at the development and implementation stages. Based on the previous stage, it can be seen that the multiple-representation based e-LKPD is considered very valid by expert validators and users. In the small-scale trial, there was an increase in the N-Gain results and the results of observations of learning implementation from meeting one to meeting four as well as the results of the average student response questionnaire in the valid category. In the class scale trial, the category was valid for SMPN 1 Arjasa and very valid for SMPN 1 Wonosari and MTsN 3 Banyuwangi.

DISCUSSION

The discussion of the results of this research includes the development of multi-representation-based e-LKPD that is valid, practical, and effective. Validity testing is a step taken to test the content. The purpose of the validity test is to measure the accuracy of the substance to be used in research (Hakim et al., 2021). Practicality is obtained based on the implementation of learning (Choirullita et al., 2020). Effectiveness refers to the results achieved in the form of pre-test and post-test (Arif & Eby, 2020).

a. Valid Multiple-Representation based E-LKPD

Validity is a measure that can show the level of reliability or validity of a product which stimulates several aspects of assessment (Mirnawati et al., 2022). Validity is carried out by experts by considering aspects of content, language, presentation and graphics. Validation is said to be complete if the validator states that a product is valid, so a trial can be carried out. The products developed are adjusted to input from validators (Sari et al., 2022). Validation was carried out by three expert validators, namely material experts, media experts, and development experts (Monica et al., 2021).

Validity results were obtained from expert and user assessments before multi-representation-based e-LKPD on living creature classification material was used in learning on a small scale and class scale. If the product being developed is said to be very valid and suitable for use, it can proceed to practical testing (Ani & Lazulva, 2020). The validator assessment is not only on the e-LKPD being developed but also on the learning support instruments or devices on the multi-representation based e-LKPD that will be used. Validated learning tools include teaching modules and pre-test and post-test questions. Liiman et al. (2022) explained that the pre-test was carried out before learning to determine students' initial abilities and the post-test was carried out to determine abilities after learning. Overall, the multi-representation-based e-LKPD validation on living creature classification material is considered valid so it can be carried out to the next stage. This is to the theory of that Angriani et al. (2020) that the learning media is included in the valid category or suitable for use at the next stage, namely small-scale use trials.

b. Practical Multiple-representation

The practicality of e-LKPD based on multiple representations of the classification of living things is determined based on the results of student responses and observations of learning implementation. Student response questionnaires are used to determine student responses to the use of the learning media developed(Kartini & Putra, 2020). The student response questionnaire was obtained via Google Forms. Apart from the student response questionnaire, to find out the practicality of multiple-representation based e-LKPD through observations of learning implementation. Mahfudin et al. (2020) state that in the learning process observations or assessments are carried out by observers through learning implementation sheets.

The practicality of multiple-representation-based e-LKPD is also supported by observations of learning implementation during teaching and learning activities. The purpose of this observation is to determine the implementation of learning using multi-representation based e-LKPD.Observations of learning implementation are carried out by observers at the same time as the learning process is taking place (Murwanto et al., 2022). The main function of implementation observation is to observe and evaluate the extent to which learning activities are implemented using products that have been developed (Wijaya & Cahyaka, 2023). The implementation of the learning process can be analyzed through observation sheets. The observation sheet is filled in by the observer to assess teacher activities and student activities during the learning process (Maulida et

al., 2021). Based on the description above, e-LKPD based on multiple representations of the classification of living things is said to be practical for use in learning.

c. Effective multiple representation

The effectiveness of e-LKPD based on multiple-representations on the classification of living things in this research to improve students' scientific reasoning was analyzed through pre-test and post-test scores. The pre-test is given before learning and the post-test is given at the end of each lesson. Product effectiveness can be assessed based on student learning outcomes (Kholifahtus et al., 2021). The effectiveness of multi-representation-based e-LKPD was measured during small-scale trials and class-scale trials.

A small-scale trial was carried out by 9 students of class VII C SMPN 2 Tanggul in four meetings. At each meeting, a pre-test and post-test are carried out which refer to Lawson's Classroom Test of Scientific Reasoning (LCTSR). The results of this description can be seen in Graph 1. Based on Graph 1, it can be seen that there has been an increase in the average student scientific reasoning score for each indicator. These indicators consist of conservation reasoning, correlation reasoning, probabilistic reasoning, proportional reasoning, variable control, and deductive hypothesis reasoning. The results of the increase in the average score of students' scientific reasoning in conservation reasoning were 16.25, correlation reasoning 14.36, probabilistic reasoning with a mean of 14.61, proportional reasoning with a mean of 16, controlling variables with a mean of 12.25 and deductive hypothesis reasoning with a mean of 13.11.

The next effectiveness test is on the class scale which lists the pre-test and post-test scores based on Lawson's Classroom Test of Scientific Reasoning (LCTSR) indicators. Class scale trials were carried out at three schools including SMPN 1 Wonosari, SMPN 1 Arjasa, and MTsN 3 Banyuwangi. Based on this table, there was an increase due to the e-LKPD presented consisting of several representations, including verbal representations, images, graphs, and tables. This is to the theory of Anggraini et al. (2022) that based on multi-representation LKPD can improve students' cognitive abilities. This can also help students understand concepts and master problem-solving techniques. Multiple-representation-based LKPD has three main objectives, namely completing students' cognitive phase, reducing the possibility of additional interpretation errors, and fostering deeper mastery of concepts (Putri et al., 2020). Multiple representation has three main functions, namely as a complement, interpretation, and building understanding (Mahardika & Wicaksono, 2023).

CONCLUSION

The multiple-representation based E-LKPD on living creature classification material is included in the very valid criteria based on the average validation results by three expert validators and users. The validation results by the validator on the material aspect were 81.66 (very valid), the media aspect 86.4 (very valid), and the development aspect 85.33 (very valid). For expert users with an average of 87.6 (very valid). Multiple-representation based E-LKPD on the classification of living things is included in very practical criteria based on the results of student response questionnaires and the results of observations of learning implementation. In the small scale trial, the results of the student response questionnaire were 78 (practical) and the results of observing the implementation of learning were 87.11 (very practical), while in the class scale trial the student response questionnaire score of SMPN 1 Wonosari was 81.28 (very practical) and the observation results implementation of learning 84.10 (very practical), SMPN 1 Arjasa student response questionnaire score 78.9 (practical) and observation results of learning implementation 86.12 (very practical), and MTsN 3 Banyuwangi student response questionnaire score 87.72 (very practical) and observation results of learning implementation 89.23 (very practical). E-LKPD based on multiple representations of the classification of living things can improve students' scientific

reasoning abilities obtained from increasing the N-Gain score at each meeting. In small-scale trials, the average value *N-Gain* score was 0.48 (medium), while in the class scale trial of SMPN I Wonosari it was 0.49 (medium), SMPNI Arjasa 0.54 (medium), and MTsN 3 Banyuwangi 0.69 (medium). This is based on multiple representations e-LKPD can be used as a benchmark or reference for conducting further research on different materials and adding other representations besides verbal representations, pictures, graphs, and tables.

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Diversity of plant as a complementary to the staple food of dawanese east nusa tenggara

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Article Info	ABSTRACT
	The Dawanese have a staple food which is also a typical food, namely bose and katemak, the manufacture of which utilizes a variety of cereal plant resources and is generally served with a complement in the form of local vegetables or typical chili sauce of the Dawan people. This study aims to determine the types of plants used by the Dawan community as a complement to staple food. Exploration methods and interviews were conducted to obtain information on the names of species and plant parts used. The plant data obtained were identified and then analyzed descriptively. The results showed that there were 12 types of plants from the *Solanaceae, Rutaceae, Apiaceae, Lamiaceae, Amaryllidaceae, and Alliaceae* families which were generally used in the manufacture of chili sauce typical of the Dawan community. The plant parts used are leaves, fruit, and tubers. Knowledge about plant utilization needs to be accompanied by knowledge about plant preservation and conservation efforts.

INTRODUCTION

Indonesia is known as a nation with a high level of diversity. This can be seen in the existence of natural resources and existing human resources. Apart from being known as an archipelagic country consisting of thousands of large and small islands and having a high wealth of biodiversity, Indonesia is also known to have a diversity of customs and cultures that are different with their uniqueness and peculiarities found in every community group. The existence of biodiversity and the diversity of customs and cultures has a relationship and its relation to one another. The diversity of customs and culture of each community group is supported by the existence of biological resources in terms of the use and utilization of the biodiversity that exists around that group of people, and vice versa, the condition and sustainability of biological diversity

are influenced by the habits of the community in terms of utilization and preservation (Setyowati et al., 2005; Kuni, 2015).

The use of biological diversity in people's living habits is reflected in the form of activities using various types of plants as a source of fulfilling their daily needs. For the need for boards, certain parts of various types of plants have been utilized as building materials and household furniture. In terms of clothing, plants are also known as the basic ingredients for making clothes and dyes. In addition to these two needs, meeting food needs is also included in the form of community needs which in their use and utilization depend a lot on the diversity of plant resources (Ariyanti, 2010). As a food source, it is also known that various types of plants are widely used by various community groups as a source of staple food and complementary food.

The Dawan tribe is one of the many tribes in East Nusa Tenggara, which is the original inhabitants of the island of Timor, especially the western part of Timor. The Dawan tribe is spread over three districts namely Kupang, South Central Timor, and North Central Timor. Like Indigenous peoples in general, the Dawan people have various forms of traditions, customs, and local wisdom, such as farming habits on dry land ecosystems, traditional ceremonies, making traditional clothes, making traditional houses, and traditional food (Bria & Binsasi, 2020; Naisumu et al., 2022; Nitti et al., 2022). In carrying out the customs and culture of the Dawan people, of course, this cannot be separated from the availability of natural resources, especially the diversity of plant species on the island of Timor.

The Dawan tribe community utilizes the potential of plant resources in various traditions and habits to fulfill their daily needs. The Dawan tribe utilizes the potential of plants, especially the cereal group, as a traditional staple food consisting of corn and various types of legumes and legumes. In the tradition of the people, this local processed food is usually served with a complement consisting of various local vegetables and lu'at which is also made from a mixture of herbs and spices. Serving lu'at as a complementary food is an inseparable custom in the traditions of the Dawan people (Naisali & Bria, 2022).

The food needs of the people on the island of Timor, both food groups as a staple food and food as a complement, cannot be denied that it is greatly supported by the diversity of plants that grow in ecological conditions which are dominated by dryland ecosystems and also the local wisdom of the community in agricultural systems and farming techniques. Research on the diversity of types of herbs and spices as a complement to the staple food of the Dawan tribe is urgently needed as a form of documentation and information regarding one form of utilization of plant biodiversity in the diversity of customs and culture of the community. This research aims to determine the kind of herbs and spices used to make traditional chili sauce by Dawanese in North Central Timor.

RESEARCH METHODS
Research Design

This research was conducted in July-August 2023 in five subdistrics of North Central Timor: Noemuti, West Miomaffo, East Miomaffo, Insana, South Bikomi, and Kota Kefamenanu. Methods of data collection are done by the method of explorations and interviews (Figure 1).
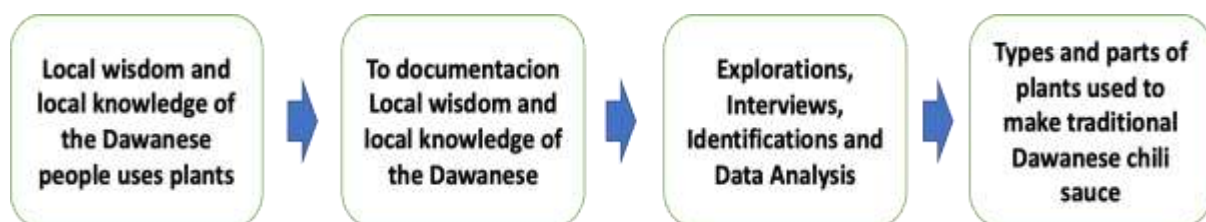

Figure 1. Flow chart of research

Population and Sample

The Dawan community in North Central Timor Regency is the population in this research. Respondents who became the samples of this research were 20 housewives from the Dawan community who were selected randomly (purposive random sampling) over 40 years old, to find out the names of plants and parts used in making local chili sauce to complement the staple food of the Dawan people.

Instruments

Equipment to support this research includes a list of questions in a questionnaire, writing tools, samples of plant types obtained during interviews, a plant identification guidebook, and the PlantNet application.

Procedures

This research was carried out by interviewing housewives with questions related to knowledge, habits, ingredients, and types and parts of plants used in making traditional chili sauce. Data interview from each respondent was tabulated based on the type and part of the plant used. For local plant species whose scientific names are not yet known, identification is carried out using plant identification guides such as determination keys, websites, and plant identification applications. Results of the analysis obtained data on the number of types and parts of plants used to make traditional chili sauce by the Dawanese community.

Data Analysis

The observed data were then analyzed descriptively using qualitative and quantitative approaches as well as literature studies to assist in describing the data observed.

RESULTS

The Dawan tribe is an indigenous people who inhabit the island of Timor, especially the western part of Timor. The Dawan people have various unique and interesting cultural forms which are reflected in traditional ceremonies and rituals as well as in daily life. Traditional houses, woven cloth, and special food as well as some local wisdom such as food processing techniques and agricultural systems are cultural products of the Dawan people which are cultural assets and at the same time an attraction in cultural tourism. The cultural products found in the Dawan people are inseparable from the use of the rich local biodiversity on the island of Timor.

The uses of plant biodiversity by the Dawan community can be seen in local food preparations that use various types of cereal plant groups. Corn and local beans are the main ingredients in the typical Dawan food preparations, known as *bose* and *katemak*. Bose is a processed product using corn kernels that have had their husks removed and cooked by boiling together with various nuts and a mixture of certain parts of several plant species, while processed katemak uses whole corn kernels without removing the husks with various nuts. and a mixture of certain parts of several plant species.

Bose and *katemak* as staple foods in the preparation and presentation are also added with complementary foods consisting of various local vegetables and spices. the local vegetables used in the presentation are cooked together with corn while local spices are processed into the special chili sauce of the Dawan people. As part of a staple food complement, local vegetables and chili sauce provide a distinctive taste in the presentation of *bose* and *katemak*. Types of local vegetables that are commonly used in the manufacture and serving of katemak include kelor (*Moringaceae*), papaya (*Caricaeae*), pumpkin (*Cucurbitaceae*), and also several plants from the families

Euphorbiaceae and *Moraceae*. Parts of the plant used as vegetables include leaves, flowers, and young fruit.

The Dawan people also have the habit of serving sambal as a complement to enjoying *bose* and *katemak*. *Lu'at* is a traditional chili sauce of the Dawan people which has a distinctive taste because it uses a blend of spices from local plants. Knowledge about making lu'at is included in local community knowledge that has been passed down from generation to generation. The types of herbs and spices used to make the traditional sambal of the Dawan people are presented in Table 1.

Table 1. The type of plant used to make the typical Dawan chili sauce

Family	Species	General Name	Local Name	Part used
Solanaceae	*Capsicum frutescens*	Cabai rawit	Unus	Fruit
	Solanum licopersicum	Tomat	Kauliman	Fruit
Rutaceae	*Citrus hystrix*	Jeruk purut	Leol mina	Fruit
	Citrus aurantifolia	Jeruk nipis	Muik masi	Fruit
Apiaceae	*Pimpinella sp*	Adas manis	Sipa	Leaf
	Coriandrum sativum	Ketumbar	Kuenter	Leaf
	Cuminum sp	Jintan putih	Ut kapas	Leaf
Lamiaceae	*Ocimum africanum*	Kemangi	He'lo	Leaf
	Menta sp.	Mint	Onatlao	Leaf
	Plectranthus amboinicus	Sukan	Luwek mafauban	Leaf
Amaryllidaceae	*Allium cepa*	Bawang merah	Pio mtasa	Tubers and leaf
Alliaceae	*Allium sativum*	Bawang putih	Pio muti	Tubers

The use of plants by the Dawan tribe as a staple food or as a complement to staple food uses certain parts of a plant. From the exploration results, it is known that the parts of the plant used in making traditional chili sauce are leaves, fruits, and tubers. The most widely used part of the plant is the leaves. The percentage of plant parts used in making traditional Dawan chili sauce is presented in Figure 2.
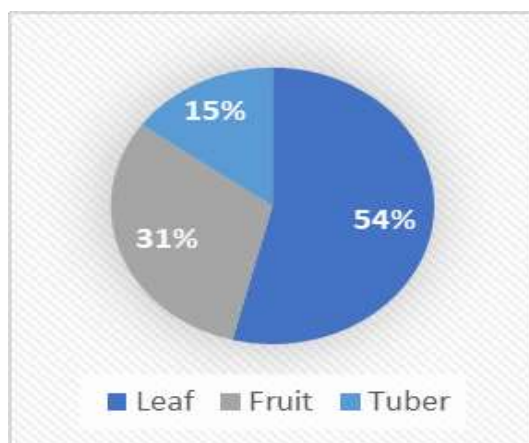

Figure 2. Percentage diagram of the use of plant parts in making Dawan's typical chili sauce

DISCUSSION

Lu'at is a traditional sambal of the Dawan people which is made using a mixture of several herbs and spices and is consumed without going through the cooking process first. The traditional chili sauce of the Dawan people can be in the form of fresh chili sauce or chili sauce that has been stored for some time. The term lu'at is more used for sambal which is made and stored for some

time before being consumed. In the culture of the Dawan people, serving lu'at is an integral part of serving staple food both in daily life and in certain traditional events.

The exploration and identification results in Table 1 show that 12 types of spice plants are used as ingredients for making chili sauce to complement the staple food of the Dawan people. The twelve plant species systematically belong to 6 different plant family groups, namely *Solanaceae, Rutaceae, Apiaceae, Lamiaceae, Amaryllidaceae,* and *Alliaceae.*

Plants from the *Solanaceae* family are used in making the special chili sauce of the Dawan people, namely cayenne pepper and tomatoes. Cayenne pepper is a spice whose composition is dominant and is also the main ingredient in making chili sauce because it gives a spicy taste. The spicy taste produced by cayenne pepper can increase appetite so that sambal lu'at has its taste as part of the complement to the staple food of the Dawan people. The spicy taste of cayenne pepper is due to the content of capsiacinoid compounds. Cayenne pepper is known to contain higher capsiacinoid compounds than other chili groups (Barbero et al., 2008) so it gives a strong spicy taste sensation when compared to other chili groups. Cayenne pepper and tomatoes are known to contain chemical compounds such as flavonoids, alkaloids, phenolic saponins, vitamin A, and vitamin C which function as antioxidants and antimicrobials against pathogenic bacteria (Kalogeropoulos et al., 2012; Chaudary et al., 2018; Izah et al., 2019; Kusnadi et al., 2019; Isaac and Oluyomi, 2020). The use of tomatoes in making Dawan's special chili sauce is not a must, meaning that tomatoes are not a mandatory spice ingredient in making lu'at. Because of its nature and its sour taste when stored, tomatoes are used to make fresh chili sauce which is eaten immediately, not stored.

Kaffir lime or lime is a plant belonging to the *Rutaceae* family which is also used as a mixed ingredient for making chili sauce typical of the Dawan people. The addition of orange juice and/or slices of citrus fruit along with the peel of the fruit makes this traditional sambal of the Dawan people sour in taste with a fresh citrus aroma. Making sambal lu'at can use a mixture of the two existing types of oranges or can use one type of orange. Lime and kaffir lime fruit contain flavonoids, alkaloids, phenols, saponins, tannins, and steroids which have pharmacological activities as antibacterial, antifungal, antihelmintic antioxidants, anticancer as well as anticholesterol (Okwu et al., 2008; Sitinjak, 2017; Permata et al., 2018; Oikeh et al., 2016).

Plants of the *Lamiaceae* family that are used in making sambal lu'at are basil, mint, and sport. These three types of plants have a distinctive taste and aroma, the selection of the addition of these three types of plants also depends on people's tastes. In its manufacture, you can use these three types of plants at once or only add one type. Plants of the Lamiaceae family are known to contain essential oils so they are widely used as medicinal ingredients and also as cooking spices (Handayani, 2015). The phytochemical content of *Lamiaceae* plants is known to have potential as antioxidants, antidiuretics, antibacterials, antifungals, and anti-inflammatories (Cocan *et al.*, 2018; Sulaiman *et al.*, 2020).

The *Apiaceae* family, anise, cumin, and coriander are plant species that are used as additives in making the typical chili sauce of the Dawan people. Just like the plants of the Lamiaceae family, these three plants also have a distinctive taste and aroma. Sipa or anise is usually used in making fresh chili sauce or stored for some time, while the addition of cumin and coriander is only for making fresh chili sauce. The addition of these three types of plants in making the typical Dawan chili sauce depends on the tastes of the people, usually only using one of these three types of plants. Sipa is the most identical type of plant in the mixture for making lu'at. Coriander, anise, and cumin are herbaceous plants in the Apiacea family that can be used as cooking spices and which are known to contain chemical compounds that have the potential as antimicrobials and antioxidants (Wei *et al.*, 2019; Zengin *et al.*, 2019).

Shallots, which are plants from the Amaryllidaceae family, and garlic from the Alliaceae family, are included in herbs and spices which are also used as additional ingredients in making the special chili sauce typical of the Dawan people. These two types of plants have a distinctive taste and aroma, so they are widely used as spices and herbs in Indonesian cooking. In making Dawan's signature chili sauce, the use of shallots and garlic also depends on taste. Usually people add these two plants at once, but there are also those who only add one of these two types of plants. Shallots and garlic are reported to contain chemical compounds such as alkaloids, flavonoids, tannins, saponins (Laia, 2019).

During the harvest season, if there is an excess of spice plants, the Dawan people will process them into lu'at to be stored as supplies for some time, even up to several months. This is included in one of the local wisdom knowledge of the Dawan community in processing and preserving food ingredients, especially in terms of food spices as a complement to serving staple food.

Plants have complete organs which generally consist of vegetative organs, namely roots, stems, and leaves; vegetative organs namely flowers, fruits, and seeds and in some plants have additional modified organs such as rhizomes, roots, or tubers (Tjitrosoepomo, 2016). Use of herbs and spices in the manufacture of special chili sauce by the Dawan people uses a combination or combination of certain parts of plants, namely leaves, fruit, and tubers. Of the twelve types of plants, the leaves are the part of the plant that is most dominantly used in making the typical Dawan chili sauce (Figure 2). The fruit organ is the part that uses the percentage more after the leaves compared to the tuber which uses the percentage less when compared to the other two plant organs. In making and presenting it, the composition of the amount of each type of plant depends on taste or habit.

The plants used in the manufacture of the typical Dawan chili sauce are known to contain certain phytochemicals of each type used and are known to be useful in supporting and supporting metabolism and biological activity. Serving the typical food of the Dawan people, namely bose and katemak with a complement in the form of lu'at chili sauce, can increase appetite and also increase nutritional value because it uses a variety of natural plant ingredients with good ingredients for health.

The diversity of plant species used by the Dawan community is inseparable from the availability of biological resources on the island of Timor and their farming habits. The people of Timor Island have a habit of farming dry land with a multicultural cropping pattern or what is known as intercropping. This is done in order to obtain various types of crops in one growing season due to the shorter duration of the rainy season. In planting areas or gardens planted with staple crops such as corn, they are intercropped with legumes or spices.

Knowledge about the use of spices in making chili sauce as a complement to the staple food by the Dawan people is a tradition inherited and passed down by their ancestors for generations. The Dawan people consider that understanding and knowledge about the use of plants in various cultural customs, especially as food, is part of the ancestral heritage that needs to be preserved and passed on to the next generation.

In addition to knowledge about the use of plants as a food ingredient, several previous studies have also reported on people's habits in using plants in making woven fabric dyes, making traditional houses and in traditional ceremonies. Nitti et al., (2022), reported that there were 4 types of plants used as natural dyes for woven fabrics of the Dawan community in Tunbaun Village, Kupang Regency; Naisumu et al., (2022), reported that there were 8 types of plants used as natural dyes for woven fabrics of the Dawan community in Fafinesu Village, North Central Timor District; Bria and Binsasi (2020), reported that there were 15 types of plants used in making traditional houses for the Dawan community in North Central Timor District.

Preservation of local community knowledge about the use of plants in fulfilling the necessities of life which in practice is carried out daily or continuously, needs to be accompanied by knowledge about plant preservation and conservation. This is necessary in relation to the availability of plant species needed in customary activities or community habits. Utilization without being followed by conservation activities can have an impact on the rare or difficult to find plant species and can even result in the threat of extinction of certain plant biodiversity in their natural habitat. The loss of biodiversity of plant species needed at an event or community's customary habits can also have an impact on the non-functioning of the program or customary habits and even the loss of customary habits or traditions in the use of plants.

The knowledge of the Dawan people in the use of plants as staple food, staple food supplements, natural dyes, or in making traditional houses needs to be preserved and passed on to the next generation given the modernization developments that introduce the use and utilization of ready-to-eat packaged foods or chili sauce and dyes. synthetic which can threaten the knowledge of future generations regarding the use of plants in the customary habits of the Dawan people.

CONCLUSION

The Dawan people on Timor Island are known to utilize a variety of plant diversity to meet their need for food. *Bose* or *katemak* which are processed local foods are usually served with complementary foods in the form of *lu'at*. The results of the identification show that 12 types of herbs and spices are usually used in making the typical chili sauce of the Dawan people. The twelve plants belong to 6 families, namely *Solanaceae, Rutaceae, Apiaceae, Lamiaceae, Amaryllidaceae,* and *Alliaceae*. Leaf, fruit, and tuber are the parts used in making the typical chili sauce of the Dawan people. The results of this research will become a part of the documentation of plant biodiversity in local wisdom and reference in local plant conservation.

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Article Info	ABSTRACT
	The importance of mastering laboratory equipment for Biology Education students encourages the development of a website-based encyclopedia as an interactive and easily accessible learning resource. This study aims to determine the characteristics of the media, the level of validity, and the level of practicality of the website-based encyclopedia on the material of introduction to laboratory equipment as support for laboratory engineering courses in the Biology Education Study Program, UIN Alauddin Makassar. The study was a research and development (R&D) based on the ADDIE development model, which included five steps: analyze, design, develop, implement, and evaluate. The results showed that the website-based encyclopedia media on laboratory equipment introduction material for the laboratory engineering course in the Biology Education Study Program UIN Alauddin Makassar has first-rate characteristics with an average expert validator rating of 100%. The media has a validity level of 3.66 means a very valid category. The media's level of practicality, as assessed by both students and lecturers, fell into the very high criteria, with a rating of 3.57 from students and 3.62 from lecturers. Therefore, the website-based encyclopedia media for introducing laboratory equipment is suitable and recommended for integration into the learning process.

INTRODUCTION

Technology has become important, especially in the 21st century. Technology has entered all fields, including education. In education, technology is a channel for transferring knowledge everywhere. The influx of technology that continues to develop causes changes in people's lives, including perspectives, dynamics, and lifestyles (Grabe, 2007; Ghavifekr & Rosdy, 2015). With the existence of technology in education, of course, all institutions must support the use of

technology in learning. In addition to innovations that continue to develop, generations need to be skilled in using them to keep up with learning progress.

(Khusnah et al., 2020) stated that the use of mobile phones in learning has been rife. This indicates that teachers must work hard regarding learning materials. That shows how technology has made learning more dynamic, demanding innovation and creativity. Carpenter et al. (2020) said educators, through professional development university programs, are responsible for providing qualified teachers to help students reach their potential. (Bingimlas, 2009) also emphasized that technological innovation can improve teachers' pedagogical competence and facilitate students' learning. (Carpenter et al., 2020) said teachers ought to be able to use technology. Professional teacher programs at higher education institutions should take the availability of teachers with these skills into consideration. Students can succeed at their highest potential with the help of their teacher. (Bingimlas, 2009) Similarly technology can facilitate student learning and increase teacher pedagogical skills.

Learning media can help students achieve learning goals. This shows the role of the media as an effective messenger. Learning media can make learning productive (Shafira et al., 2018). Therefore, the media must be adapted to the characteristics of students, achieve learning goals, be simple, according to learning methods, and be motivated (Rasyid et al., 2016). Recognizing laboratory equipment, of course, requires appropriate media. Introduction to laboratory equipment is one of the basic materials in laboratory engineering courses. It said in (Gökmen et al., 2021) that laboratories are important in accomplishing educational objectives and improving learners' retention of subject matter. They extend beyond merely imparting scientific knowledge by promoting essential skills such as scientific research, discussion, and critical thinking. Actively participating in laboratory work not only deepens students' comprehension of scientific concepts but also nurtures essential abilities for both academic and personal growth. (Restiana & Djukri, 2021), said that Laboratory equipment represents a technological advancement aimed at enhancing skills and addressing the demands of the modern era. Consequently, students are required to be familiar with the proper utilization of this equipment. Apart from skill development, familiarity with laboratory equipment and chemicals also aids in grasping the underlying learning theories. This ensures the effective execution of subject-specific practical exercises and facilitates students' comprehension of the theoretical concepts previously taught in the classroom.

Encyclopedias, as a form of learning media, are a valuable resource for easy-to-understand information enriched with colorful pictures, keeping readers engaged and interested (Handayani et al., 2021). The Encyclopedia serves as a valuable reference source commonly utilized for explanatory purposes. It encompasses two main types: general encyclopedias and special encyclopedias, both offering a wealth of knowledge on various subjects. Whether seeking comprehensive overviews or in-depth information on specific topics, these encyclopedias stand as essential tools for individuals seeking to expand their understanding and knowledge across a diverse range of subjects. Based on the type of media there are print, digital, and electronic encyclopedias (Hermanto et al., 2021).

Web-based encyclopedias allow users to actively construct knowledge through exploration and interaction with various sources of information. Several studies have shown that the use of online encyclopedias can improve students' learning motivation, conceptual understanding, and learning outcomes.

Nevertheless, findings from interviews with Biology Education students at UIN Alauddin Makassar have brought to light a concerning issue - the scarcity of resources for laboratory equipment introduction. The limited availability of relevant materials in the library makes it arduous for students to access essential information, leading them to resort to Internet sources that often lack appropriateness and adequacy. In light of this predicament, there arises a pressing need

for an open-access manual that comprehensively presents clear descriptions, accompanied by pictures and detailed explanations of laboratory equipment. Such a resource would undoubtedly prove invaluable in bridging the knowledge gap and empowering students to engage effectively in their academic pursuits.

Several studies regarding the introduction of laboratory equipment have been carried out. These studies focused on chemical laboratory equipment (Priyambodo et al., 2017) and the Digital Encyclopedia of Electrical Technology in the field of physics (Nurhatmi, Rusdi, et al., 2015). Studies on biology laboratory equipment have been conducted by (Huda et al., 2018) and (Supriyadi & Lismawati, 2018), who developed printed encyclopedias for high and junior high schools. (Ferastia, 2022), has also created mobile learning-based encyclopedias for junior high school students. One study about encyclopedias for laboratory engineering courses at the university level was done by Sitti Nur Ramadhanty. Unfortunately, It took the shape of printed material on A4-sized Art Paper. In this research, laboratory equipment, especially for laboratory engineering courses, was developed in a website-based encyclopedia. This website-based encyclopedia includes images, functions, and usage instructions for laboratory tools. The study uses Figma for prototype design and implements it into the Laravel Framework as the website medium, with data input via XAMPP and Visual Studio Code applications. The Canva Pro application is utilized for image and icon editing, ensuring the design incorporates graphic elements.

The use of encyclopedias contributes significantly to an enriched learning experience, promoting a deeper understanding of subjects and fostering a thirst for knowledge in students. This development of a biology laboratory equipment encyclopedia aims to familiarize students with lab tools, enabling them to become independent and active in practicum activities. This development of a biology laboratory equipment encyclopedia aims to familiarize students with lab tools, enabling them to become independent and active in practicum activities. Supriyadi & Lismawati, (2018), stated that utilizing the encyclopedia would improve comprehension of laboratory tool names and functions among students.

RESEARCH METHODS
Research Design

This type of research is called research and development abbreviated as R&D (Haka et al., 2021). The main purpose of this research is to create new products or improve existing products based on previous iterations (Saputro, 2017). Research and development can be tested according to the level of testing that can produce valid, practical, and effective results. The learning media in this study were compiled and developed using the ADDIE development model. The ADDIE development model has simple, structured, and systematic stages. The ADDIE development model consists of five stages, namely Analyze, Design, Develop, Implement, and Evaluate.

Population and Samples

The sample consists of 19 students from class B in Biology Education 2022. Validation was carried out by 2 validators, namely lecturers from the Biology Education Study Program. The validators consisted of media experts who provided assessments of the specifications of the media developed and material expert validators who provided assessments of the content of the media.

Instruments

The research instruments comprised media characteristic sheets, validation sheets, and questionnaires. The characteristic sheet served as a valuable reference for discerning the distinctions between previously developed media, media created by researchers, and other learning media. Expert assessors or validators directly evaluate the validation sheet to determine the validity of the

media. Furthermore, a questionnaire was given to the lecturer and students containing a list of questions or statements used to see the level of practicality of the media developed and to collect feedback from the learning process after using the media created by the researcher.

Procedures

The analysis stage begins with an analysis of student needs related to the learning media used. The design and development stage is carried out by designing and developing laboratory tools in web form through a validation process by expert validators. The results of product development were implemented with class B Biology Education students to see the effectiveness of media. After that, the product is evaluated based on input from students and lecturers.

Data Analysis

The data obtained were then analyzed descriptively. The data obtained from the results of the validation sheet and the response questionnaire were arranged in a table to facilitate identification. Instrument data were obtained from the recapitulation of the results of the expert validator assessment and the student and lecturer response questionnaire. The average obtained was then interpreted, the media characteristic category in Table 1, the validity level criteria in Table 2, and the practicality level criteria in Table 3.

Table 1. Media Characteristics Categories

Persentase	Characteristics Category
76% - 100%	Very good
56% - 75%	Quite good
40% - 55%	Not good
< 40%	Not good

Table 2. The Validity Category

Mean	Criteria
$3,5 \leq M \leq 4$	Very valid
$2,5 \leq M < 3,5$	Valid
$1,5 \leq M < 2,5$	Quite valid
$M < 1,5$	Not valid

Table 3. The Practicality Category

Mean	Criteria
$3,5 \leq Xi < 4$	Very Practical
$2,5 \leq Xi < 3,5$	Practical
$1,5 \leq Xi < 2,5$	Quite Practical
$0 \leq Xi < 1,5$	Not Practical

RESULTS

Characteristics of Website-Based Media Encyclopedia

Characteristics are something distinctive or striking that is found in a person or an object or thing. Based on the results of the analysis of assessment data by expert validators using the Guttman scale, the characteristics of website-based encyclopedia learning media obtained an average assessment value of all aspects, namely 100%, which is included in the very good category. This is supported by Dessyta Gumanti's theory (2021) that if the results of the analysis of learning interest

assessment data by respondents using the Guttman scale are at a percentage of 76% - 100%, it is categorized as very good. So it can be concluded that the characteristics of website-based encyclopedia media are very good for use in learning.

Website-Based Encyclopedia Media Validity Level

Based on the results of the analysis of the media validity level test that has been carried out by researchers, the website-based encyclopedia media obtained an average value of all aspects of 3.66 or is in a very valid category (Table 4). So, it can be concluded that the website-based media encyclopedia on laboratory equipment introduction material is feasible to use in the learning process. This is by the theory which states that if the average value of the media validity test results is $3.5 \leq M < 4$ then the media is in the very valid category (Ridwan: 2003).

Table 4. Validator Assessment Results

Assessment Aspect	Rating Result	Category
Appearance	3,5	Very Valid
Media Contents	3.75	Very Valid
Technical Quality	3,33	Very Valid
Size	4	Very Valid
Appropriate Use of Terms	3.75	Very Valid
Average	3,6	Very Valid

Level of Practicality of Website-Based Encyclopedia Media

The practicality level was assessed using two research instruments: a student response questionnaire and a lecturer response questionnaire. After analyzing the practicality test results, the student response questionnaire yielded a score of 3.57, while the lecturer response questionnaire scored 3.68. The overall average response, calculated as 3.62, falls within the "very practical" category (Table 5). Thus, it can be concluded that website-based encyclopedia media is highly practical for implementation in the learning process. This conclusion aligns with the theory that categorizes media with an average practicality test score between 3.5 and 4 as "very practical" (Fairuz et al., 2020).

Table 5. Results of the Response Questionnaire Analysis of Supporting Lecturers and Students

No.	Types of Research	Average	Assessment Criteria
I	Lecturer's Response	3.68	Very Practical
2	Student Response	3.57	Very Practical
	Average Number	3,62	Very Practical

DISCUSSION

Characteristics of Website-Based Media Encyclopedia

Characteristics are inherent attributes or features that distinguish and make a person or object unique or remarkable (Kadir et al., 2021). The analysis of assessment data by expert validators, utilizing the Guttman scale, revealed that the website-based encyclopedia learning media exhibited exceptional characteristics, obtaining an average score of 100% in all aspects, falling within the "very good" category. This finding aligns with (Gumanti & Teza, 2021) theory, which stipulates that when the assessment data using the Guttman scale reaches a percentage range of 76% to 100%, it is classified as "very good" (Gumanti & Teza, 2021).

Figure 1. Development of Website-Based Encyclopedia

In appearance aspect, this medium boasts a clear and orderly layout, complemented by a pleasing color combination and an array of captivating features. The website-based encyclopedia media employs a well-proportioned arrangement of fonts and colors that seamlessly blend with the typography (Figure 1). Additionally, it incorporates intriguing features housing relevant learning materials, accompanied by illustrative icons representing each laboratory tool.

Moving on to the content aspect, this medium encompasses lucid learning materials sourced from reputable books, journals, and researchers' laboratory observations. It ensures that the content aligns cohesively with the required competencies. In terms of language, the medium utilizes easily understandable language, catering to the needs of its users and ensuring a user-friendly experience. Furthermore, from a technical perspective, this medium's usability requires no specialized skills, thereby eliminating potential hindrances for students during its usage. According to (Sunarto et al., 2020), creating a successful learning application demands a user-centric approach, prioritizing the needs and requirements of the application's users over the preferences of the creator. The application's relevance to the cultural context in which it will be implemented is of utmost importance, ensuring its effectiveness and resonance with the target audience. To achieve excellence in a learning application, careful consideration must be given to aligning it with the characteristics, technology, and context of the learning system. By adhering to these principles, a well-designed and culturally relevant learning application can pave the way for a truly impactful and successful educational experience.

The results of this study find support in the research by (Cahdriyana & Richardo, 2016), which delineates various characteristics of effective learning media. These include having clear learning objectives, relevant and accurate content, a coherent learning flow, unambiguous usage instructions, and provision of perceptions, conclusions, examples, and exercises with accompanying feedback. Effective media also stimulates student learning motivation, includes evaluations with results and discussions, engages students with interesting intros, incorporates harmonious and proportional visual elements like images, animations, texts, and colors, offers interactivity, features easy navigation, and employs language that is easily comprehensible to students (Cahdriyana & Richardo, 2016).

Website-Based Encyclopedia Media Validity Level

The validity of learning media includes aspects of format, content, and language obtained from the validator's lecturer validation results (Saniriati et al., 2021). The developed medium is determined by its validity level. If the validity level of the learning medium falls below the required standard, revisions are essential to ensure it achieves a valid validation level (Simanjuntak, 2019).

The display aspect in terms of fonts uses the Fascinate Inline font type in the title section on the homepage and Poppins in the features, descriptions of tools, functions, how to use, sources, and other elements. The use of Poppins as the main typeface on website-based encyclopedia media because Poppins is a San serif typeface classified in a geometric San serif form, with characters that represent the impression you want to make, namely dynamic and easier to read (Adi, 2020).

The right colors in multimedia learning can generate motivation, feelings, attention, and interest in student learning. Therefore, a good understanding of color selection is needed for the development of learning multimedia, including website-based media encyclopedias (Purnama, 2010). The choice of background color on the dominant website is white to match the color of the writing. The white color reflects a positive, bright, and assertive character (Langga et al., 2020). The blue color is used in tools made of glass and porcelain. Using blue as a product indicator gives the impression of a cool taste. Thus, the use of blue will make students comfortable with the learning media being developed (Masturah et al., 2018). The brown color on the wooden tool part characterizes the material that makes up the wooden tool itself. Brown means natural, warm, grounded, and more stable (Nurdini et al., 2018). Plastic and metal tools are denoted in gray according to the color of the laboratory equipment where they were made. Gray is associated with neutral colors. The color gray means balance, safety, natural, classic, simple, mature, intellectual, and justice (Monica & Luzar, 2011).

According to Zakiya, Sinaga & Hamidah, 2017; and Yulianti et al., 2021, the diverse range of representation modes in this learning content is genuine, contributing to the enrichment of knowledge insights and the enhancement of student comprehension of the material. This means the significance of using multiple representation modes in learning content. "Representation modes" refer to different ways of presenting information, such as text, images, videos, diagrams, and interactive elements. By incorporating a variety of representation modes, the learning content becomes more diverse and authentic, closely mirroring real-world scenarios. The various representation modes in learning content bring real-life context, enrich knowledge insights, and bolster student understanding, making the learning experience more comprehensive.

Level of Practicality of Website-Based Encyclopedia Media

Appropriate use of technology can serve the regular education classroom by motivating students in all disciplines. The research conducted by Asare & Parker (2022), demonstrates the significant positive impact of web-based instruction on students' understanding of biology concepts as well as their engagement and critical thinking abilities. Notably, the study revealed that students easily adapted to web-based software, finding it neither boring nor time-consuming. Moreover, web-based instruction effectively catered to individualized learning needs, further enhancing the learning experience for students. While a minority of students expressed some reservations, the overall findings highlight the immense potential of web-based technology as a valuable tool for biology instruction, fostering a more interactive, efficient, and engaging educational journey.

The results of this study are also supported by a theory that states that practicality refers to the condition of learning media that is developed so that it is easy to use by users, both students and teachers so that learning is carried out in meaningful, interesting, fun, and useful ways for students, as well as increasing creativity in learning. This is in line with the study of (Astuti et al., 2020), which states that students have expressed excitement and appreciation for this website, as it has been instrumental in enhancing their understanding. Thus, students stay engaged in their lessons by exploring the menus on the web, which is interesting.

Several things must be considered related to the media created. The format must be considered first, as it will determine how the media will be presented and how much time and

money will be required. The second is the suitability of students, namely the suitability of media content with the development and experience of students, and the third is the suitability of educators, namely the suitability of media with the learning carried out by educators and being able to facilitate students and understand the material through the developed media (Milala et al., 2022).

Based on the result, the practicality of media for students and teachers refers to the extent to which the media is useful, functional, and effective in supporting the teaching and learning process. The lecturers' responses to the website-based encyclopedia media are assessed based on appearance, convenience, desire for learning objectives, and usage. In terms of appearance, the media effectively captures students' attention through attractive displays, including easy-to-understand images and appropriate color and font choices for introducing laboratory tools. As for convenience, the website-based encyclopedia proves accessible on various devices (Windows, Android, and iOS) without requiring special skills. Its presentation of interconnected material aids students in understanding the functions and usage of laboratory equipment, making it a valuable learning resource. Student responses align with the lecturers', emphasizing the website-based encyclopedia's role in facilitating learning objectives. The media contributes to students' understanding of laboratory equipment introduction, thereby aiding in the achievement of learning goals. Additionally, the website's ease of use further enhances its effectiveness as a learning tool for students.

Overall, both the lecturers and students recognize the significance of the website-based encyclopedia media in supporting the learning process. Its visually appealing and user-friendly features, along with its alignment with learning objectives, make it a valuable asset for enhancing students' understanding and application of laboratory equipment concepts. This positive reception can increase the likelihood of achieving the desired learning outcomes. Sayan & Mertoğlu, (2020), argued that the incorporation of equipment in Biology education proves highly effective in facilitating students' cognitive, affective, and psychomotor development. During laboratory work, the impact on affective and psychomotor aspects becomes more pronounced. The presence of various experimental tools in laboratory settings, plays a significant role in motivating students and instilling a passion for scientific exploration. This statement emphasizes the importance of a high level of validity and practicality in the media. Choosing the right medium with good validity and practicality shows effective and interesting material content (laboratory introduction). Under these conditions, content is presented in a form that is easy to understand, accessible, and ultimately leads to satisfying learning outcomes. Puspitarini & Hanif (2019) said that technology-based media is very valuable. If this type of media is used properly, it can improve learning outcomes. This type of media that utilizes the internet can encourage effectiveness, liveliness, dynamics, and independence in learning.

Apart from the positive results of the validity and practicality tests, this study has limitations. In this study, no effectiveness test was carried out, and the practicality test was only carried out on one expert lecturer, so there is a possibility of subjectivity. Further studies should carry out a more extensive evaluation.

CONCLUSION

Based on the research and discussion, the developed website-based encyclopedia media exhibits an appealing appearance with well-combined colors. It offers user-friendly features, making it accessible to all users without the need for special skills. The validity level of the website-based encyclopedia media used to introduce laboratory tools for the Biology Education Study Program at UIN Alauddin Makassar is highly commendable, with an average value of 3.66, classifying it as a very valid resource. The practicality level of the website-based encyclopedia media, utilized in

introducing laboratory equipment for the Biology Education Study Program at UIN Alauddin Makassar, receives accolades from both students and supervising lecturers. Based on the student response questionnaire, achieves an impressive average score of 3.57, while the supervising lecturer's questionnaire yields an even higher average score of 3.68, placing it firmly in the very practical category. The results of this study are expected to improve students' knowledge and understanding, especially in the introduction to laboratory equipment, and contribute to the development of science and technology.

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