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The contribution of local wisdom integrated science learning model to students' scientific communication skills in ecology learning

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ABSTRACT

Science learning can be integrated with local culture in the form of learning models. This study aimed to analyze the contribution of the local wisdom integrated science (LWIS) learning model in practicing scientific communication skills of prospective science teachers in Ecology learning. This study used a quasi-experimental of posttest only control design and purposive sampling technique from prospective science teachers at Trunojoyo University, Madura. The research instrument was a test of scientific communication skills, observations of the implementation of the LWIS learning model, questionnaire and interview responses of prospective science teachers to ecological learning using the LWIS learning model. Data analysis techniques used the t-test significance level of 5%. The results showed that (1) there were differences in the scientific communication skills of prospective science teachers after using the LWIS learning model of significance of 0.014 < 0.05 and $-t_{count} < t_{table} < t_{count}$ (-2.528 < 1.9996 < 2.528), (2) scientific communication skills in the experimental class by 94.87% (high) > control class by 88.03% (high), (3) implementation of the LWIS learning model obtained an average value of 100% (very good), and (4) the response of prospective science teachers obtained an average value of 89.40% (very good) for the experimental class and the prospective science teacher said that the learning model was new, easy to use, developed scientific communication skills. Thus, it can be concluded that the LWIS learning model contributes positively in training the scientific communication skills of prospective science teachers in Ecology learning.

Introduction

The 21st century world faces the era of the Industrial Revolution (R.I.) 4.0. This era was marked by increasing digitization of manufacturing. The increase was driven by four factors, they were: (1) strengthening of data volume; (2) the emergence of thinking abilities; (3) new forms of interaction occur; and (4) the use of robotics (Idin, 2018; Wibawa & Agustina, 2019). It is influenced human activities that carried out in the scale, scope, complexity, and transformation of life experiences. The challenges and opportunities of R.I 4.0 encourage innovation of educational creations in 21st century learning (Xu, David, & Kim, 2018).

21st century learning in the era of R.I. 4.0 is oriented towards strengthening the brain in thinking. Strengthening the brain in thinking requires thinking skills, such as Critical-Thinking Skills, Problem-Solving Skills, Collaboration Skills, Creativity and Innovation Skills, and Communication Skills (Bybee, 2010; Davies, A., Fidler, D. and Gorbis, 2011; Lee, Lapira, Bagheri, & Kao, 2013). Scientific communication skills are needed by students to explain valid conclusions based on scientific evidence. Scientific communication emphasizes scientific language through the application of learning principles (Duran, 2014; Yusuf & Adeoye, 2012). The principle in the learning that is carried out is assessing initial understanding, connecting facts with a conceptual framework, monitoring metacognitive, determining performance, and providing feedback (Kyllonen, 2012).

Students' scientific communication skills can be seen from 6 indicators, they are explaining information in an effective, detailed, and systematic manner, conveying individual/group work, describing the characteristics of an object, describing written scientific explanations, making charts/graphs, and summarizing scientific information (Deryati, Abdurrahman, & Maharta, 2013; Iksan et al., 2012). It will be an obstacle for students in expressing their ideas if their communication skills are not developed. Students will experience difficulties in the process of composing thoughts and the relationship of an idea to other ideas (Duran, 2014; McNeill, 2011). Scientific communication skill is important to train students in learning. It is very important to be trained especially for Science students as the teacher candidates, because they are educators and teachers of science in junior high schools.

Based on the results of the preliminary study (April-May 2019) in the Science education of the Faculty of Education, Trunojoyo University, Madura, it showed that the scientific communication skills of 110 students in ecology courses was 28.33% (low). The test data was also supported by the results of learning observations that students were often feel nervous and unconfident while having presentation, and other students did not understand what the presenter said. Students who didn't understand were just silent, they didn't ask questions, they were just passive and even made some noise. The results of the preliminary study were also strengthened by the *teacher-oriented* learning process factor. The learning process was directed on memorizing and it was not training the thinking skills.

The description of the learning problems occurred showed that the lecturer was less active and innovative, and he did not use media and learning resources from the natural ecosystem environment. In fact, science can be taught as if science was obtained that is a scientific approach. The scientific approach helps to build students' understanding through 5 stages, as follows: observing, asking questions, gathering information/trying, reasoning/associating, making conclusions and communicating (Savelsbergh, de Jong, & Ferguson-Hessler, 2011; Villagonzalo, 2014). Students are encouraged to seek knowledge from various sources through engaging cognitive processes that stimulate intellectual development.

One of the learning resources that can be used comes from the local cultural traditions, in this case the Madurese people. For example, the Madurese people in the month of Syuro perform the ritual of *rokat tasik*. *Rokat tasik* is providing food or other things to the sea, to give feedback of the increase of fish catch by fishermen. The assumption of the Madurese community as a belief is not necessarily true (indigenous knowledge). Knowledge of beliefs can be studied as knowledge if it can be proven scientifically through experiments and literary studies (scientific knowledge).

The illustration of the example above shows the relationship between public knowledge and science in the form of science material (ecosystem), scientific method, and scientific process skills, which is called ethnoscience. Ethnoscience examines the influence of people's opinions on socio-culture as part of the results of real behavior in creating their environment changes (Sudarmin, 2014; Yuliana, 2017). Therefore, ethnoscience can be integrated in science and biology learning, such as ecology.

Integrating ethnoscience with ecology requires a learning model. The purpose of the learning model directs the learning process and outcomes according to learning syntax and theory (Ogan-Bekiroglu & Aydeniz, 2013; Walker, Sampson, Grooms, Anderson, & Zimmerman, 2010). From the study of ethnoscience, learning theory, and the development of the R.I. 4.0 at this time, it is necessary to develop an innovative learning model. The innovative learning model offered is Local Wisdom Integrated Science (LWIS). This learning model was developed based on the learning theory of behaviorism, social, cognitivism, constructivism involving pedagogy and andragogy, integrating public cultural knowledge in science that is expected to have an instructional and accompanying impact (Mungmachon, 2012; Pornpimon, Wallapha, & Prayuth, 2014). The expected instructional impact is in the form of strengthening the brain in thinking, especially the skills to communicate the integration of indigenous knowledge in scientific knowledge. The expected accompanying impact is a learning experience for students, especially as a science teacher candidate they have to study, integrate, and preserve local culture.

The Local Wisdom Integrated Science learning model has 5 syntax, which are: 1) problem identification activities through enculturation of local wisdom; 2) problem solving activities based on local wisdom; 3) reconstructing of findings through assimilation of local wisdom; 4) communicating the results of solving problems scientifically; and 5) evaluating of the process through acculturation of local wisdom, which is studied theoretically and empirically (Mungmachon, 2012; Pornpimon et al., 2014). The LWIS model development has been validated and declared to be valid based on the content and its construction.

The development of the Local Wisdom Integrated Science model is designed to integrate indigenous local cultural communities through enculturation, assimilation, and acculturation (Aikenhead, 2006; Pornpimon et al., 2014). Proving the truth of people's cultural knowledge (indigenous knowledge) can be done through experiments and scientific literature studies (scientific knowledge). Proving the truth of people's cultural knowledge (indigenous knowledge) can be done through experiments and scientific literature studies (scientific knowledge). It is automatically if there will be material from the results of community cultural studies that are integrated into science and biology learning. Cultural integration in science learning is a learning innovation and a place for the preservation of cultural values.

Based on the background, analysis of the problems and solutions offered, so a study to analyze the local wisdom integrated science learning model is occurred, it is planned to train students' scientific communication skill in Ecology lecture/learning.

Method

The research design used in this study is quantitative research with experimental method. The experiment used was *quasi-experimental design* with *posttest only control* design.

The experiment class was taught by the LWIS based learning, then control class was taught by conventional method (without any learning model combination). *Local wisdom integrated science learning model* has 5 syntax, which are: 1) problem identification activities through enculturation of local wisdom; 2) problem solving activities based on local wisdom; 3) reconstructing of findings through assimilation of local wisdom; 4) communicating the results of solving problems scientifically; and 5) evaluating of the process through acculturation of local wisdom, which is studied theoretically and empirically (Baynes & Austin, 2012; Mungmachon, 2012; Pornpimon et al., 2014). Both *local wisdom integrated science learning model* or conventional method were given for 3 meetings each class.

The purposive sampling technique was used to select the sample. The subject of the study was the students of Science Education of Natural Science Faculty of Trunojoyo University, Madura in

2018/2019 generation. There were thirty-two students from class A as control group and other thirty-two from class B as experiment group. The samples used in the two classes were equivalent in terms of age, educational background, knowledge and the students' area of origin, that is Madura.

The research procedures have some steps, those were class surveys, learning tools preparation, developing instruments to measure students' scientific communication skills, observing the implementation of LWIS-based learning, measuring student responses to ecological learning that is carried out, validating instruments, collecting validation results, analyzing validity and reliability test data, and analysis. data. The research was conducted for 3 meetings in the Ecology course by utilizing the local Madurese culture. The first meeting discussed the understanding and organizational units in the ecosystem through the Madura study called salt land. The second meeting discussed various kinds of ecosystems through the study of Batu Jaddih which was explored and exploited illegally and *rokat tasik*. The third meeting discussed the food chain and food web through the impacts of illegal exploration and exploitation of Batu Jaddih and *rokat tasik*. Each meeting conducted a study from observations and interviews with the community so that indigenous knowledge was obtained, then it was proven using scientific knowledge from experiments and literature studies.

The instruments used to collect data were tests of scientific communication skills, observations of LWIS implementation, questionnaires and student responses to ecology learning. Scientific communication skills tests have been developed by Spektor-Levy, Eylon, & Scherz (2008) and it was declared valid and reliable by using the Alpha formula (Ratumanan & Laurens, 2011). The scientific communication skills test consists of 6 indicators which are described in Table 1.

Item size was used to investigate the difficulty level of each test item. Items were considered valid when they met two or three item size criteria that indicate a validated test instrument could be used to collect data.

Table 1. Matrix for assessment of scientific communication skills

Assessment Aspects	Indicators
Spoken Scientific Communication	Explaining information in an effective, detailed, and systematic manner Delivering individual/ group work Describing the characteristics of an object
Written Scientific Communication	Describing written scientific explanations by making charts/graphs Summarizing scientific information

(Deryati et al., 2013; Spektor-Levy et al., 2008)

The validation process was carried out by experts to determine the validity of the observation sheets, questionnaires and interviews. These instruments were sequentially used to collect data on the implementation of the local wisdom integrated science learning model and student responses to ecology learning using the local wisdom integrated science learning model. Data from the validation of observation sheets, questionnaires and interviews were processed using the following Aiken's V formula 1.

The data on students' scientific communication skills tests collected are tested for normality and homogeneity. The normality test is used to investigate whether the data is normally distributed or not, while the homogeneity test is used to investigate whether the data is homogeneous or not. The normality test uses the Kolmogorov-Smirnov test and the homogeneity test uses the Levene test, the significance level of each test is 5% (0.05), with the help of SPSS software version 20.

$$V = \frac{\Sigma s}{[n(c-1)]} \quad \text{..................................(1)}$$

(Azwar, 2016)

Notes:
V : Content validity of Aiken's V
S : r-lo
Lo : Minimum validity assessment number (in this case = 1)
c : Maximum validity assessment number (in this case = 5)
r : Number given by the validator

Data is distributed normally and/ homogeneously when the significance level is greater or the same with 5% (Sugiyono, 2015). After the normality and homogeneity tests were carried out on the results of the scientific communication skills test data, the researchers conducted an independent sample t-test to compare the LWIS model learning with conventional learning at the 5% (0.05) significance level with the help of SPSS version 20. The criteria for testing the hypothesis testing independent sample t-test, so when $-t_{count} < t_{table} < t_{count}$ and when the significance level is greater than or equal to 5%, then H0 is rejected and H1 is accepted (Sugiyono, 2015). Calculating the difference between the students' scientific communication skills in the experimental class and the control class, the test results data were analyzed using the following formula 2.

$$Percentage = \frac{respondent\ score}{score\ total} \times 100\% \ldots\ldots\ldots\ldots (2)$$

(Deryati et al., 2013)

The results of calculating the percentage of students' scientific communication skills tests are then interpreted by the response category in Table 2.

Table 2. Matrix for assessing students' scientific communication skills test

Percentage	Categories
75.01% - 100%	Very high
50.01% - 75.00%	High
25.01% - 50.00%	Low
0% - 25,00%	Very Low

(Sapriadil et al., 2018)

The observation data on the implementation of learning using the local wisdom integrated science learning model were analyzed using the following formula 3.

$$carried\ activity = \frac{the\ number\ of\ step\ implement}{the\ number\ of\ steps} \times 100\% \ldots(3)$$

(Sunarto & Riduwan, 2013)

The results of the percentage calculation of learning implementation and students' responses are then matched with the criteria/categories in Table 3. The results of calculating the percentage of are then interpreted by the response criteria/ categories in Table 3.

Table 3. Learning implementation assessment matrix

Percentage	Categories
75.01% - 100%	Very Good
50.01% - 75.00%	Good
25.01% - 50.00%	Low
0% - 25.00%	Very Low

(Sunarto & Riduwan, 2013)

The interview data as a response to learning using LWIS are used to explore in-depth information about learning responses. Data from students' responses of the interview are analyzed using data triangulation, including data collection, data reduction, data presentation, and drawing conclusions or verification (Sugiyono, 2015).

Results and Discussion

This study used tests of scientific communication skills, observations of the implementation of the local wisdom integrated science learning model, questionnaires and interviews with students' responses to ecology learning using LWIS. This study used an experimental class taught by LWIS, while the control class was taught using conventional methods (without any combination of learning models). The research was conducted for 3 meetings in the Ecology course by utilizing the local Madurese culture. The research data are described as follows.

Instrument Validity

Validation was carried out on observation sheets, questionnaires and interviews. These instruments were sequentially used to collect LWIS implementation data and students' responses to the ecology learning using LWIS. The data from the validation results of the observation sheet, questionnaire and interview were shown in Table 4.

Table 4. Validity instrument results

No	Assessment aspects	Assessment score V1	Assessment score V2	Average	Categories
Instrument of model implementation observation sheet					
1	Format	4	4	4	Very valid
2	Content	4	4	4	Very valid
3	Language	4	4	4	Very valid
Questionnaires response instruments					
1	Format	4	4	4	Very valid
2	Content	4	4	4	Very valid
3	Language	4	4	4	Very valid

Based on Table 4, the results of the validation of the LWIS implementation observation sheet and the response questionnaires by two experts showed that the format, content, and language aspects each got a score of 4 and were declared very valid with 100% reliability (Ratumanan & Laurens, 2011). These results showed that the instrument of the learning implementation observation sheet and the response questionnaires developed were very valid to be used.

The Prerequisite Test for Normality and Homogeneity

Data on students' scientific communication skills were obtained through tests using the developed test sheets Lev dan Eylon (2008) and declared valid and reliable by using the Alpha formula (Ratumanan & Laurens, 2011). The data on students' scientific communication skill tests that have been collected were tested for normality and homogeneity. The results of the posttest data normality test for students' scientific communication skills were listed in Table 5.

Table 5. The results of the normality test of students' scientific communication skills

Class		Kolmogorov-Smirnov			Decision
		Statistic	df	Sig.	
Score	Experiment	0,110	32	0,200	Normal
	Control	0,107	32	0,200	Normal

Based on Table 5, it was obtained that the significance value of the experimental and control posttest respectively is 0.200. That was, the significance value of the experimental and control posttest was greater than 5% so that it could be stated that all posttest data on students' scientific communication skills in the experimental and control class were normally distributed (Sugiyono, 2015). After knowing that the data was normally distributed, the homogeneity test was carried out. The results of the posttest data homogeneity test of students' scientific communication skills can be seen in Table 6.

Based on Table 6, it was obtained a significance value of 0.891. That, the significance value was greater than 5% so it could be stated that all posttest data on scientific communication skills given to students has a homogeneous variant (Sugiyono, 2015).

Table 6. The results of the homogeneity test of students' scientific communication skills

Levene's Statistic	df1	df2	Sig.	Decision
0,019	1	62	0,891	Homogeny

Hypothesis Test Results

After knowing that the posttest data on students' scientific communication skills were normally distributed and had homogeneous variants, the researchers conducted an Independent sample t-test to compare the LWIS learning model with conventional learning. The results of the Independent sample t-test can be seen in Table 7.

Table 7. Test results of the Independent sample t-test

		F	Sig.	t	df	Sig (2-tailed)
Score	Equal variances assumed	0,019	0,891	2.528	62	0.014
	Equal variances not assumed			2.528	61.807	0.014

Based on Table 7, it was shown the results of t_{count} (2.528) > t_{table} (1.9996). Based on the results of the Independent sample t-test, then H0 was rejected and H1 was accepted.

It showed that there were differences in students' scientific communication skills before and after the implementation of the LWIS model. The difference between students' scientific communication skills in the experimental class and the control class from the results of the test data analysis was shown in Figure 1.

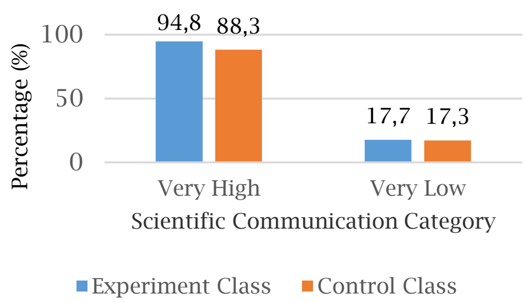

Figure 1. The results of the posttest data analysis of students' scientific communication skill

Based on Figure 1 students' scientific communication skill in the experimental and control classes were categorized as very high and very low. There were differences in students' scientific communication skill when compared in the two categories in the experimental and control classes. Figure 1 showed that the scientific communication skills of the experimental class students were higher than the control class. These results indicated that the LWIS model has an effect on students' scientific communication skill.

The impact of LWIS model on students' scientific communication skill appears when identifying problems through enculturation of local wisdom from observations and interviews, solving problems based on local wisdom through group discussions, reconstructing findings through assimilation of local wisdom from collaborative concept map making, communicating the results of scientific problem solving, evaluating the process through acculturation of local wisdom, which was studied theoretically and empirically (Baynes & Austin, 2012; Mungmachon, 2012; Pornpimon et al., 2014).

Observation was done by students to the society in a certain area in Madura. Students determined research themes/ topics related to community knowledge about environmental, social, and local cultural conditions from observations, of course related to ecological material. Students conducted interviews according to the theme/topic to the community to explore information and community assumptions (indigenous knowledge). During the interview, students composed questions and communicated to the public to get as much information as possible. Interview activities could support students in practicing scientific communication skills effectively (Baynes & Austin, 2012; Mungmachon, 2012).

The results of the interviews were discussed by students with their group members to solve problems based on local wisdom. The solution to the problem was to prove indigenous knowledge using scientific knowledge from literature studies and experiments. This proof was needed to strengthen, add to, or refute indigenous knowledge. This was necessary to educate the community so that indigenous knowledge was the opinion of the community which was made into knowledge whether it was true or not. Of course, it was accompanied by reasons and scientific evidence. It was in line with Gondwe and Longnecker (2015), and Suastra (2010) that the local wisdom proof is the truth that has been a tradition in an area, it was done to manage the point of views and the life strategy of the community. Students automatically also studied about ecological material related to indigenous knowledge and scientific knowledge. The ecology material studied by students was the understanding and organizational units in ecosystems, various ecosystems, food chains and food webs. Proving indigenous knowledge with scientific knowledge made students increased their thinking capability, both in science process skill, critical thinking skill, creative thinking skill, collaboration skill, and communication skill through a scientific approach (Koizumi, 2017; Kurniawati, Wahyuni, & Putra, 2017).

The results of student discussions with their groups were arranged in the form of a concept map/ mind mapping (See Figure 2 and Figure 3). The concept map/mind mapping created a reconstruction of the scientific findings obtained. Making a concept map/mind mapping was done by determining the main concepts and supporting concepts. The main concept and supporting concepts were connected with conjunctions on the concept map, while the mind mapping activities did not use conjunctions. Concept maps were made by students in a specific and deep thinking to know the meaning, types, similarities and differences, examples, and concept applications (Mahanal, Avila, & Zubaidah, 2018).

The concept map/mind map form was adjusted to the interests and creativity of each student. It made students enjoyed in constructing their own meaningful understanding and learning and it was easier to communicate (Ab Latif, Mohamed, Dahlan, & Mat Nor, 2016; Atay & Karabacak, 2012).

Figure 2.The concept maps

Students communicated the concept maps/mind maps with the results of scientific writing explanations, charts/ graphs made, and summaries of scientific information. Concept maps/mind maps were communicated through presentations to exchange opinions, to get input and suggestions from other groups and lecturers. Presentations were made by conveying ideas, data collection processes, results, reconstruction of scientific findings. Students explained information in an effective, detailed, and systematic manner, convey the results of group/individual work, describe the characteristics of the object under study. Good communication techniques made the study presented easier to be understood by the audience. It is in line with that scientific communication learning can be developed by training the students to be a good presenter (Sasson & Dori, 2015; Schwab, 2017). The undeveloped scientific communication skill troubled the students to socialize and work productively (Bybee, 2010; Kyllonen, 2012; McNeill, 2011).

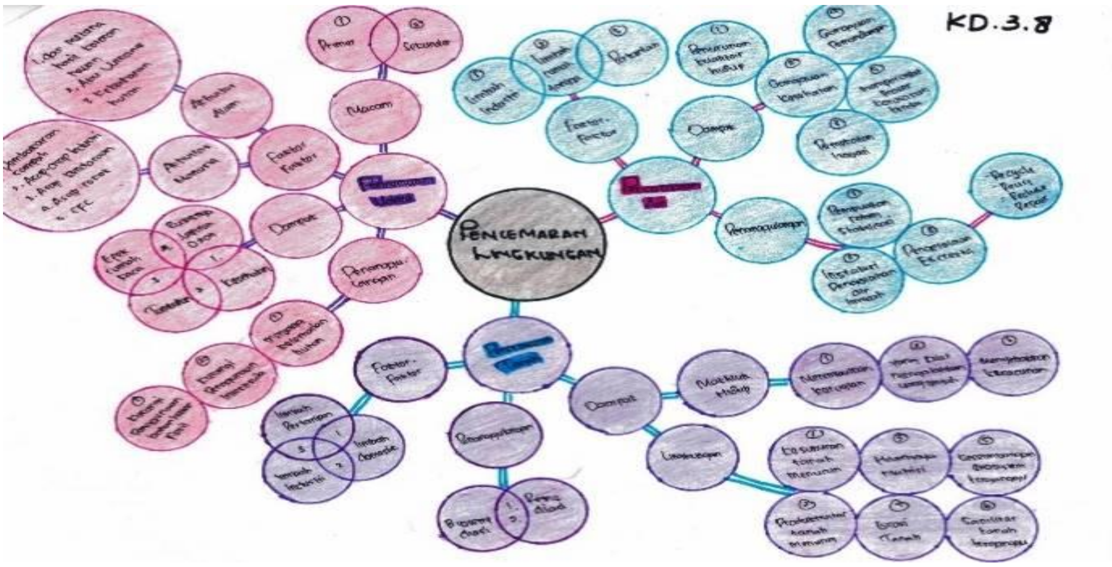

Figure 3.The mind maps

Students evaluated the concept map/ mind map made and wrote the suggestions from other groups and lecturers after the presentation. The purpose of evaluation was to have a self-correction of the process and reconstruction's results of scientific findings that could add, strengthen, or refute indigenous knowledge using scientific knowledge. Reasons with supporting scientific evidence were also needed to perfect the reconstruction of scientific findings. The results of the evaluation carried were then compiled in the form of a scientific report written in paper/ article/ essay/ poster. Making scientific reports exercised students' scientific communication skill, especially the use of easy language understanding (Yusuf & Adeoye, 2012).

Students came to the community according to the initial research location to provide the scientific report. Students conducted socialization on the results of the research carried out. Socialization was done to educate the public about the community's opinion which was made as knowledge (indigenous knowledge). The education provided by students was useful for adding, strengthening, justifying or refuting indigenous knowledge using scientific knowledge, which was accompanied by reasons and supporting scientific evidence. During the process of educating the public so that people's perceptions and understanding were comprehensive and easy to understand, students need scientific communication skills. As Tatar, Tüysüz, Tosun, and İlhan (2016); Yusuf and Adeoye (2012) said that the understanding and student achievement factors are scientific communication skill. Scientific communication skill involve thinking skills in reconstructing ideas using easy language understanding (Sapriadil et al., 2018).

The treatment in the experimental class using the local wisdom integrated science learning model makes students understand the importance of local wisdom culture and scientific communication skills. The use of local culture in science learning in ecology courses connects scientific concepts and scientific thinking in everyday life. The culture of local wisdom was integrated in science learning through 3 things, they are enculturation, assimilation, and acculturation (Aikenhead, 2006; Pornpimon et al., 2014; Sapriadil et al., 2018). These three things are listed in the LWIS model.

Enculturation is the process of studying the cultural values experienced by individuals and communities. Students align science content from school with the perspective they have through enculturation. The enculturation process is carried out by taking inventory of science content that is in line with local wisdom during observations and interviews. Thus scientific thinking skills can color the way people think (Villagonzalo, 2014).

Assimilation is a process of exchanging cultural elements to navigate the differences between groups. The assimilation process can be adopted in integrating local wisdom culture with science which is carried out when proving indigenous knowledge with scientific knowledge and reconstructing findings. Students learn science content that is incompatible with the point of view they have, replacing that point of view with a scientific perspective in everyday life through the process of assimilation (Aikenhead, 2006; Pornpimon et al., 2014; Sapriadil et al., 2018).

Acculturation is a social process that arises when a group of people with a certain local wisdom culture is faced with elements of foreign culture. Gradually, foreign cultural elements will be accepted and processed into their own culture without eliminating the original culture. The acculturation process between science content and local wisdom can be carried out by taking inventory of science content that has useful values according to the past, present, and future needs of students and society. Science content is used to replace old ideas that do not suit your needs or add new ideas based on local wisdom values, knowledge, skills, and attitudes. The acculturation process by communicating the results of the reconstruction of scientific findings that occurred and evaluating the value of local wisdom can improve the quality of life of the community.

The difference in scientific communication skill in the two classes were accompanied by the indicator's improvement of each scientific communication skill. The results of a more detailed analysis of students' communication skill for each indicator between the experimental and control classes are presented in Figure 4.

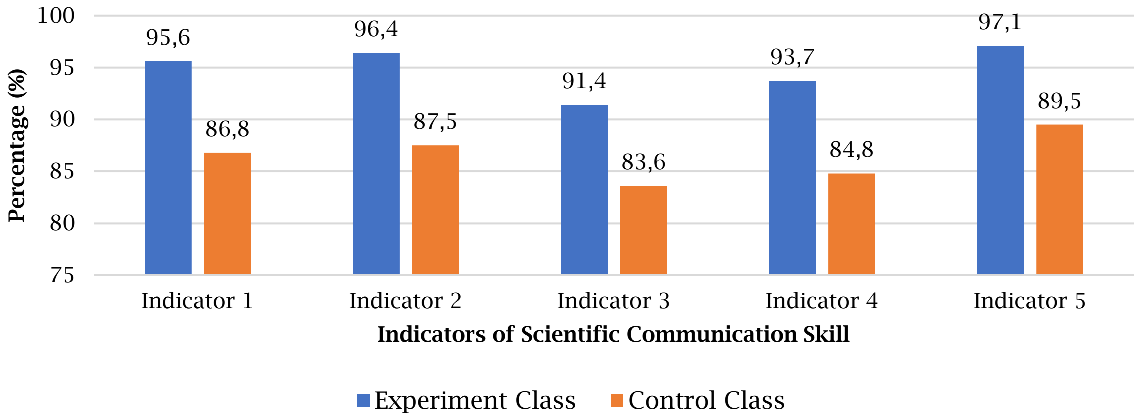

Figure 4.The results of data analysis on student scientific communication skills on each indicator of the experimental and control class (Indicator see Table 1)

Based on Figure 4 we know that the percentage of each indicator of students' scientific communication skill in the experimental class was greater in value than the control class. The percentage of indicators between the experimental and control classes if ordered according to the amount of progress were indicators 5 (summarizing scientific information), 3 (describing the characteristics of an object), 1 (describing information effectively, in detail, and systematically), 2 (conveying work results individual/group), and 4 (describe a written scientific explanation by making a chart/graph).

The percentage of indicator 5 (summarizing scientific information) in the experimental and control classes experienced rapid progress because students were able to capture scientific information from observations, informant interviews and presentations. Scientific information that will be obtained during observations, informant interviews and presentations were shared by group members. Each member of the group found the information according to the roles and concepts that have been determined. The information obtained was written or recorded. The information obtained by one member with other members in a group was linked and complements each other.

Students as science teacher candidates in the experimental and control classes have familiarized themselves with reading references and making summaries before starting lectures. During the lecture, students in Madura complete a summary based on additional information from the lecturer. This is supported by Cals and Kotz (2013) which stated that looking for references, reading, and understanding information from reading before starting lectures can help students summarize the scientific information obtained. The percentage of indicator 5 (summarizes scientific information) of students is in line with indicator 3 (describing the characteristics of an object). Students were able to describe the characteristics of an object that is found and recognized. The characteristics of an object that were found and recognized were the morphological state of the shape, color, size, texture, thickness, and others that were sensed (Anwar, 2010; Flinner, K., Roberts, Norlander, Beharry, & Fraser, 2016). The object was sensed using the five senses that was observed, heard, tasted, touched or smelled. The percentage of indicator 3 was not as big as indicator 5 because the object of study under study was local culture (salt soil, Jaddih stone, and Rokat tasik) which can only be described by students using 3 senses, they are eyes, ears, and skin. Students have not used the sense of tongue and nose to describe the characteristics of the object. This was due to the limitations of local culture found in society and types of culture that were in line with Ecology material.

In indicator 1 students were able to explain information which is the result of observations, informant interviews and presentations. Scientific information was explained effectively in good language and is correct and detailed in detail. It's just that students have not been able to explain information systematically because students still need time to get used to and train to think coherently and logically. Disorganized thinking will have an impact in explaining unsystematic information. While having presentation, the audience must first process and sort the information described by the presenter. From these activities, the audience could understand the information described. It is in line with the opinion of Yusuf and Adeoye (2012) that the clarity of the explanation of the information communicated is determined by the coherence and logical thinking of a person so that it will determine productive work in the team.

Students were able to submit individual/group work results according to indicator 2. Students were able to contribute to individual/group work and acknowledge the results of their work from individuals or groups. Students have not been able to convey individual/group work clearly and have not been able to provide feedback on the input, criticism, and suggestions given. For a team that works well, the process and results of the work of each individual in a group and group/team work will be good too. Therefore, the percentage of indicator 2 (submitting individual/group work) was not as large as indicators 5, 3 or 1. It is in line with the opinion Yusuf and Adeoye (2012) that the delivery of individual/group work requires individual/group scientific communication skills.

The lack of clarity in delivering information on individual/group work results on indicator 2 after further investigation was due to the fact that students were not able to make charts/graphs properly (indicator 4). Charts/graphs that are made have adjusted to the phenomena/data presented and the clarity of the charts/graphs that have been made. Students have not been able to make charts/graphs according to writing rules (in determining the x and y axes).

There are still many students who are upside down in determining the x and y axes (see Figure 5). Students were also less able to complete the description of the charts/graphs that are made (see Figure 6). Information about charts/graphs that are often missed by students was the primary horizontal and vertical axis titles, labels and legends. Therefore, the percentage of indicators conveying individual/group work is not as large as other indicators.

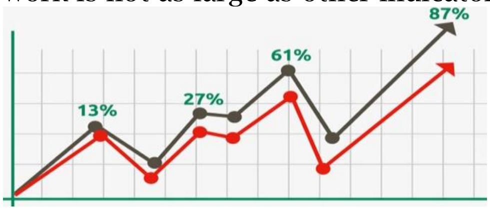

Figure 5.Error in determining the x and y axes

Errors in determining the x and y axes (Figure 5) and incomplete description of the charts/graphs (Figure 6) make the delivery of information on the work of individuals/groups as well as information explanations less detailed and systematic. The result was that the audience's understanding of the information presented is not comprehensive.

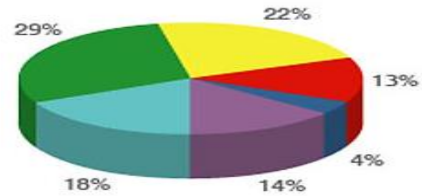

Figure 6. Description of charts/graphs is lacking

This agrees with Sasson and Dori (2015); and Schwab (2017) that audience understanding is influenced by the presenter's scientific communication skills in conveying comprehensive information. The development of students' scientific communication skill which was influenced by the LWIS model was also strengthened by learning implementation data. Learning using the LWIS model consists of 5 syntax and was occurred 3 times. The results of the implementation of learning can be seen in Table 8.

Table 8. The results of implementing learning using the local wisdom integrated science (LWIS) model

Meetings	Observer 1	Observer 1I	Average	Categories
1	100%	100%	100%	Very Good
2	100%	100%	100%	Very Good
3	100%	100%	100%	Very Good
Average			100%	Very Good

Based on Table 8 the implementation of learning using the LWIS model gets an average of 100% and is categorized as very good. The percentage of learning implementation is very good because the learning used according to the LWIS model consists of 5 syntax: 1) identification of problems through enculturation of local wisdom; 2) problem solving activities based on local wisdom; 3) reconstruction of findings through assimilation of local wisdom; 4) communicate the results of solving problems scientifically; and 5) evaluation of the process through acculturation of local wisdom, which is studied theoretically and empirically. In each syntax, the lecturer motivates students by instilling awareness of the importance of preserving local Madurese culture. Motivation encourages and activates students to imitate the model and attract attention so that students feel it is important to learn it (Arends, 2012; Emda, 2018). Lecturers also guide students to discuss problem solving and proof through the process of perception, ideation, and transmission. Different perceptual abilities between students are determined by the communication activities carried out. The more often students involve themselves in communication, the stronger their perception will be (Ameyaw, 2011). Ideation in the discussion is carried out to organize the students' perceptions so that they are ready to be transmitted verbally and non-verbally to others. In the communication process that is always trained, students will achieve success in learning (Sasson & Dori, 2015; Yusuf & Adeoye, 2012).

Lecturers provide directions when making concept maps/mind maps, communicating and evaluating them. The concept map/mind map created represents a reconstruction of the scientific findings obtained. The concept map created helps students construct their own understanding using thinking skills, one of which is scientific communication skills (Ab Latif et al., 2016; Kurniawati et al., 2017). The ability of students to change the presentation of a graphic will increase along with their cognitive level by way of cognitive apprenticeship. This process cannot happen quickly, but gradually (Gulacar, Overton, & Bowman, 2013; Lee et al., 2013).

The development of students' scientific communication skills which is influenced by the LWIS model is not only supported by the excellent implementation of the LWIS model, it is also strengthened by student response questionnaire data. The response questionnaire uses 3 indicators: interest, understanding/clarity, and satisfaction. The response questionnaire data were analyzed using formula 4. The results of the response questionnaire recapitulation are seen in Table 9.

Table 9. Results of student response questionnaires

No	Indicator	Class	Percentage and Category
1	Interest	Experiment	86.81% (Very good)
		Control	62.76% (Good)
2	Understanding/Clarity	Experiment	89.88% (Very good)
		Control	73.69% (Good)
3	Satisfaction	Experiment	91.51% (Very good)
		Control	74.52% (Good)

Based on Table 9, it was obtained that the results of the student response questionnaire were generally very good in the experimental and control classes. Student response from all indicators from Table 9. in the experimental class was 89.40% (very good) and in the control class was 70.32% (good). This indicates that the student response to the experimental class is better than the control class. Lecturers create a conducive environment for learning based on local wisdom through good classroom management. Student response in the experimental class is better than the control class is also supported by the results of interviews with students. Students say that the learning model is new, easy to use, develops scientific communication skills. "It is new because the model used does not yet exist, and integrates local culture with science in ecology courses". This makes students enthusiastic, interested, and motivated to listen to the material and take part in learning. "Easy to use because the operationalization of the applied learning model is clear, detailed, and systematic". Learning like this makes students happier than conventional methods. "Develop scientific communication skills because each model syntax trains thinking processes and communicates thinking processes". The development of scientific communication skills increases student confidence.

Conclusion

Based on the research results, it showed that the local wisdom integrated science (LWIS) model has a positive contribution to train students' scientific communication skill in Ecology learning. The novelty finding of this research was that local wisdom was integrated into ecology learning through enculturation, assimilation, and acculturation through the process of perception, ideation, and transmission, as well as students' scientific communication skill could be trained using the LWIS model. Suggestions given are that strengthening is needed in the form of cognitive apprenticeship and scaffolding during the reconstruction of local wisdom-based scientific findings on science learning, and the results of this research should be expanded to be applied to other Biology learning materials and training on various thinking skills.

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References

Ab Latif, R., Mohamed, R., Dahlan, A., & Mat Nor, M. Z. (2016). Concept mapping as a teaching tool on critical thinking skills and academic performance of diploma nursing students. *Education in Medicine Journal*, *8*(1), 67–74. https://doi.org/10.5959/eimj.v8i1.406

Aikenhead, G. S. (2006). *Science education for everyday life: Evidence-based practice.* Retrieved from https://books.google.co.id

Ameyaw, Y. (2011). Environmental pedagogies that promote students understanding of integrated science (biologi aspect). *Journal of Education*, *1*(1), 10–15.

Anwar, M. A. (2010). Role of information management in the preservation of indigenous knowledge. *Pakistan Journal of Information Management and Libraries*, *11*(1), 456–603. Retrieved from http://journals.pu.edu.pk/journals/index.php/pjiml/article/view/792/427

Arends, R. I. (2012). *Learning to teach.* London: McGraw-Hill.

Atay, S., & Karabacak, Ü. (2012). Care plans using concept maps and their effects on the critical thinking dispositions of nursing students. *International Journal of Nursing Practice*, *18*(3), 233–239. https://doi.org/10.1111/j.1440-172X.2012.02034.x

Azwar, S. (2016). *Reliabilitas dan validitas.* Yogyakarta: Pustaka Pelajar.

Baynes, R., & Austin, J. (2012). Indigenous knowledge in the Australian National Curriculum for Science: from conjecture to classroom practice. *Paper Presented at the 5th Biennial International Indigenous Development Research Conference*, 1–12. Retrieved from http://eprints.usq.edu.au/id/eprint/23219

Bybee, R. (2010). *The teaching of science: 21st century perspective.* Retrieved from https://books.google.co.uk

Cals, J. W. L., & Kotz, D. (2013). Effective writing and publishing scientific papers, part III: introduction. *Journal of Clinical Epidemiology*, *66*(7), 702. https://doi.org/10.1016/j.jclinepi.2013.01.004

Davies, A., Fidler, D. and Gorbis, M. (2011). Future Work Skills 2020. In *University of Phoenix Research Institute.* Retrieved from http://hdl.voced.edu.au/10707/194830

Deryati, P., Abdurrahman, A., & Maharta, N. (2013). Pengaruh keterampilan berkomunikasi sains menggunakan pendekatan multiple representations terhadap literasi sains siswa. *Jurnal Pembelajaran Fisika*, *1*(2), 67–77. Retrieved from http://jurnal.fkip.unila.ac.id/index.php/JPF/article/view/252/111

Duran, M. (2014). A Study on 7 th grade students' inquiry and communication competencies. *Procedia - Social and Behavioral Sciences*, *116*(1), 4511–4516. https://doi.org/10.1016/j.sbspro.2014.01.976

Emda, A. (2018). Kedudukan motivasi belajar siswa dalam pembelajaran. *Lantanida Journal*, *5*(2), 172–182. https://doi.org/10.22373/lj.v5i2.2838

Flinner, K., Roberts, S. J., Norlander, R. J., Beharry, S., & Fraser, J. (2016). *Final evaluation report: Libraries transforming communities (NewKnowledge publication #NPO.074.175.06)*. Retrieved from http://www.ala.org/tools/sites/ala.org.tools/files/content/SummativeReport_ALA LTC_2016 01 18.pdf

Gondwe, M., & Longnecker, N. (2015). Scientific and cultural knowledge in intercultural science education: Student perceptions of common ground. *Research in Science Education*, *45*(1), 117–147. https://doi.org/10.1007/s11165-014-9416-z

Gulacar, O., Overton, T. L., & Bowman, C. R. (2013). A closer look at the relationships between college students' cognitive abilities and problem solving in stoichiometry. *Eurasian Journal of Physics and Chemistry Education*, *5*(2), 144–163. Retrieved from http://www.ijpce.org/index.php/IJPCE/article/view/80

Idin, S. (2018). An overview of STEM education and industry 4.0. In M. Shelley & S. A. Kiray (Eds.), *Research Highlights in STEM Education* (pp. 194–208). Retrieved from https://www.isres.org/

Iksan, Z. H., Zakaria, E., Meerah, T. S. M., Osman, K., Lian, D. K. C., Mahmud, S. N. D., & Krish, P. (2012). Communication skills among University Students. *Procedia - Social and Behavioral Sciences, 59*, 71–76. https://doi.org/10.1016/j.sbspro.2012.09.247

Koizumi, H. (2017). Scientific Learning and Education for Human Security and Well-Being. In *Children and Sustainable Development* (Vol. 6, pp. 239–257). https://doi.org/10.1007/978-3-319-47130-3_18

Kurniawati, A. A., Wahyuni, S., & Putra, P. D. A. (2017). Utilizing of comic and jember's local wisdom as integrated science learning materials. *International Journal of Social Science and Humanity*, *7*(1), 47–50. Retrieved from http://www.ijssh.org/vol7/793-HS0071.pdf

Kyllonen, P. C. (2012). Measurement of 21st century skills within the common core state standards. *Invitational Research Symposium on Technology Enhanced Assessments*, 1–24. Retrieved from https://oei.org.ar/ibertic/

Lee, J., Lapira, E., Bagheri, B., & Kao, H. (2013). Recent advances and trends in predictive manufacturing systems in big data environment. *Manufacturing Letters*, *1*(1), 38–41. https://doi.org/10.1016/j.mfglet.2013.09.005

Mahanal, S., Avila, S., & Zubaidah, S. (2018). Potensi model pembelajaran biologi berbasis Reading-Concept Map-Cooperative Script (REMAP-CS) dan gender terhadap keterampilan berpikir kritis siswa SMA Kota Malang. *Prosiding Seminar Nasional Pendidikan Biologi*, 186–190. Retrieved from http://www.jurnalfkip.unram.ac.id/index.php/SemnasBIO/article/view/695

McNeill, K. L. (2011). Elementary students' views of explanation, argumentation, and evidence, and their abilities to construct arguments over the school year. *Journal of Research in Science Teaching*, *48*(7), 793–823. https://doi.org/10.1002/tea.20430

Mungmachon, R. (2012). Knowledge and local wisdom : Community treasure. *International Journal of Humanities and Social Science*, *2*(13), 174–181. Retrieved from http://www.ijhssnet.com/journals/Vol_2_No_13_July_2012/18.pdf

Ogan-Bekiroglu, F., & Aydeniz, M. (2013). Enhancing pre-service physics teachers' perceived self-efficacy of argumentation-based pedagogy through modelling and mastery experiences. *EURASIA Journal of Mathematics, Science and*

Technology Education, *9*(3), 233–245. https://doi.org/10.12973/eurasia.2013.932a

Pornpimon, C., Wallapha, A., & Prayuth, C. (2014). Strategy challenges the local wisdom applications sustainability in schools. *Procedia – Social and Behavioral Sciences*, *112*(Iceepsy 2013), 626–634. https://doi.org/10.1016/j.sbspro.2014.01.1210

Ratumanan, T. G., & Laurens, T. (2011). *Penilaian hasil belajar pada tingkat satuan pendidikan*. Surabaya: Yayasan Pengkajian Pengembangan Pendidikan Indonesia Timur dan UNESA.

Sapriadil, S., Setiawan, A., Suhandi, A., Malik, A., Safitri, D., Lisdiani, S. A. S., & Hermita, N. (2018). Optimizing students' scientific communication skills through higher order thinking virtual laboratory (HOTVL). *Journal of Physics: Conference Series*, *1013*, 012050. https://doi.org/10.1088/1742-6596/1013/1/012050

Sasson, I., & Dori, Y. J. (2015). A three-attribute transfer skills framework – part II: applying and assessing the model in science education. *Chemistry Education Research and Practice*, *16*(1), 154–167. https://doi.org/10.1039/C4RP00120F

Savelsbergh, E. R., de Jong, T., & Ferguson-Hessler, M. G. M. (2011). Choosing the right solution approach: The crucial role of situational knowledge in electricity and magnetism. *Physical Review Special Topics – Physics Education Research*, *7*(1), 010103. https://doi.org/10.1103/PhysRevSTPER.7.010103

Schwab, K. (2017). *The fourth industrial revolution*. Retrieved from https://books.google.co.id/

Spektor-Levy, O., Eylon, B.-S., & Scherz, Z. (2008). Teaching communication skills in science: Tracing teacher change. *Teaching and Teacher Education*, *24*(2), 462–477. https://doi.org/10.1016/j.tate.2006.10.009

Suastra, I. W. (2010). Model pembelajaran sains berbasis budaya lokal untuk mengembangkan potensi dasar sains dan nilai kearifan lokal di SMP. *Jurnal Pendidikan Dan Pengajaran*, *43*(1), 8–16. Retrieved from https://ejournal.undiksha.ac.id/index.php/JPP/article/view/1697

Sudarmin, S. (2014). *Pendidikan karakter, etnosains dan kearifan lokal (konsep dan penerapannya dalam penelitian dan pembelajaran sains)*. Semarang: Universitas Negeri Semarang.

Sugiyono. (2015). *Statistika untuk penelitian*.

Sunarto, S., & Riduwan, R. (2013). *Pengantar statistika untuk penelitian pendidikan, sosial, komunikasi, ekonomi, dan bisnis*. Bandung: CV Alfabeta.

Tatar, E., Tüysüz, C., Tosun, C., & İlhan, N. (2016). Investigation of factors affecting students' science achievement according to student science teachers. *International Journal of Instruction*, *9*(2), 153–166. https://doi.org/10.12973/iji.2016.9211a

Villagonzalo, E. C. (2014). Process oriented guided inquiry learning: An effective approach in enhancing students' academic performance. *The DLSU Research Congress*, 1–6. Retrieved from https://www.dlsu.edu.ph

Walker, J., Sampson, V., Grooms, J., Anderson, B., & Zimmerman, C. (2010). Argument driven inquiry: An instructional model for use in undergraduate chemistry labs. *International Conference of the National Association of Research in Science Teaching (NARST)*, 94–126.

Wibawa, R. P., & Agustina, D. R. (2019). Peran pendidikan berbasis higher order thinking skills (Hots) pada tingkat sekolah menengah pertama di era society 5.0 sebagai penentu kemajuan bangsa Indonesia. *EQUILIBRIUM: Jurnal Ilmiah Ekonomi Dan Pembelajarannya*, *7*(2), 137–141. https://doi.org/10.25273/equilibrium.v7i2.4779

Xu, M., David, J. M., & Kim, S. H. (2018). The fourth industrial revolution: Opportunities and challenges. *International Journal of Financial Research*, *9*(2), 90. https://doi.org/10.5430/ijfr.v9n2p90

Yuliana, I. (2017). Pembelajaran berbasis etnosains dalam mewujudkan pendidikan karakter siswa Sekolah Dasar. *ELSE (Elementary School Education Journal): Jurnal Pendidikan Dan Pembelajaran Sekolah Dasar*, *1*(2), 98–106. Retrieved from http://journal.um-surabaya.ac.id/index.php/pgsd/article/view/1051

Yusuf, F., & Adeoye, E. (2012). Developing critical thinking and communication skills in students: Implications for practice in education. *African Research Review*, *6*(1), 311–324. https://doi.org/10.4314/afrrev.v6i1.26