JPII 12 (2) (2023) 208-220

Jurnal Pendidikan IPA Indonesia

http://journal.unnes.ac.id/index.php/jpii

ETHNOCHEMISTRY POTENTIAL OF VINES CONTAINED IN LONTAR USADA TARU PRAMANA ON STUDENTS' SCIENTIFIC EXPLANATION SKILLS THROUGH TASK-BASED LEARNING

I. G. L. Wiratma*[1] & I. A. A. Yuliamiastuti[2]

[1]Department of Chemistry, Universitas Pendidikan Ganesha, Indonesia
[2]SMA Negeri 6 Denpasar, Indonesia

DOI: 10.15294/jpii.v12i2.42826

Accepted: February 17th, 2023. Approved: June 20th, 2023. Published: June 21st, 2023

ABSTRACT

This research focuses on the analysis of the ethnochemistry potential of the vines contained in the Lontar Usada Taru Pramana. Lontar Usada Taru Pramana is a note written on palm leaves about plants that are useful as medicines used as a reference for traditional Balinese medicine. This study aims to analyze the effectiveness of task-based learning that utilizes the ethnochemistry potential of vines contained in Lontar Usada Taru Pramana, on students' scientific explanations skills. This research was conducted during the post-Covid-19 period in vocational and high schools with 234 students. This research was quantitative and applied The One-Group Pretest-Posttest Design with replication where there was no control class and all research subjects were given the same treatment. Task instructions were passed through pre-task, process task, and post-task. The type of task in learning is to make scientific studies of ethnochemistry by sharing personal experiences and solving problems. The data collection technique used tests as descriptive essay questions to measure students' scientific explanation skills on some materials in booklets of Taru Pramana Lontar. The tests in this study described several components: plant classification, chemical content, benefits and methods of concocting it as medicine, and the scientific version of the Lontar Usada Taru Pramana composition. The effectiveness of task-based learning was analyzed using the N-Gain and T-test. The results of this study indicate that giving assignments based on Lontar Usada Taru Pramana in chemistry learning is effective in increasing students' ability to explain the scientific study of vines as medicine. The N-gain results are in the high category of 0.76 for vocational students and 0.72 for high school students. While the T-test result shows that there is a significant difference between students' pretest and posttest results in both vocational school and high school with a significance of <.01. Students tend to correctly give scientific explanations to the plants they often encounter. This study shows that the ethnochemistry potential of the vines on Lontar Usada Taru Pramana can improve students' scientific explanation skills. This study recommends elaborating chemistry concepts in the preservation of cultural heritage through transferring knowledge on using traditional and modern medicinal plants and their development in research.

Keywords: ethnochemistry; Lontar Usada Taru Pramana; task-based learning; scientific explanation

INTRODUCTION

Chemistry is abstract and has a strong relationship with daily needs, so reasoning is needed in studying each discussion (Carmel et al., 2019; Ugwu, 2020; Lehtola & Karttunen, 2022). Chemistry learning teaches the ability to identify chemistry problems and make inferences based on facts to discover various changes in nature and the effects of human interactions with nature (Mahaffy et al., 2018; Flynn et al., 2019; Holme, 2019). Chemistry learning is essential in various fields, such as medicine, pharmacy, food, industry, environment, and others (Musengimana et al., 2021). Many students still do not understand what chemistry concepts can do in the future, as well as several industries relevant

*Correspondence Address
E-mail: lanang.wiratma@undiksha.ac.id

to chemistry (Shwartz et al., 2021). Even though students know some of the roles of chemistry in everyday life, they still need help explaining the contextual relationship between chemistry concepts (Hajian, 2019; Rahmawati et al., 2019).

The meaning of the scientific context is needed by students so they can understand the problem and be able to explain the solution scientifically and appropriately (Kembara et al., 2020). This condition applies to general and vocational high school levels which have equal thinking skills (Wiyarsi et al., 2020). The fact is that there is a gap between the two school levels which is still a challenge for quality improvement since the current chemistry learning has not optimized the integration of chemistry with its application in everyday life (Bhure et al., 2021; Obikezie et al., 2021). The application of contextual learning that integrates learning with various real-life problems can make the learning process meaningful and improve students' critical thinking skills and overall learning outcomes (Hyun et al., 2020; Budiman et al., 2021).

Everyday activities almost always involve knowledge, including activities that become local wisdom (Kangkhao et al., 2022). Basic knowledge can provide alternative solutions to everyday problems that arise. Some local wisdom which is the product of traditional knowledge has been used to solve problems for a long time, even without the latest scientific explanation (Munandar et al., 2022). Along with the times, the younger generation needs to become more familiar with local culture and the knowledge that underlies it. Learning at school has not been able to optimally facilitate students to scientifically explore local wisdom (Ramdiah et al., 2020). Teaching and learning activities are seen as having no relationship with local culture because local culture is only passed down from generation to generation outside of school academic activities (Parmiti et al., 2021).

Integrating chemistry learning materials with activities close to students, such as culture and local wisdom (ethnochemistry) that develop in everyday life, is urgently needed to solve problems scientifically (Imansari et al., 2018; Konyefa & Okigbo, 2021). Ethnochemistry examines the chemical ideas found in various cultural practices that have existed in society for generations to become a standard concept (Ferreira et al., 2022). Ethnochemistry supports contextual, meaningful learning and involvement in preserving the nation's cultural diversity and local wisdom (Abumchukwu et al., 2021; Ramdani et al., 2021; Heliawati et al., 2022).

Indonesia as a country rich in culture has provided a variety of local cultures that are worthy of scientific study (Pratiwi & Suwandi, 2021). For example, Bali has a Lontar cultural heritage, which is writing important texts on science, Balinese culture, and all other important information on *ental/enau* leaves (palm leaves) (Muderawan et al., 2020; Sudipa et al., 2022). There are various types of Lontar manuscripts developing in society, such as *lontarwariga* (astronomy), *babad* (clan records), *kawisesan* (supernatural science), *usada* (medicine), and many others (Hinzler, 1993; Kesiman, 2019; Ginting et al., 2021). *Lontar usada* (derived from the Sanskrit "osadha" or "ausadha") is a type of lontar that contains the identification of various types of diseases written in Balinese script, usually side by side with Lontar Taru Pramana. Lontar Usada Taru Pramana is a note written on palm leaves about plants that are useful as medicine, their treatment functions, and various prescriptions for symptoms or diseases that appear (Arsa et al., 2020; Muderawan et al., 2020). Lontar Usada Taru Pramana is a cultural heritage of the Balinese people, which has a vital role in medicinal techniques that rely on herbal methods (Mediastari, 2020; Putra, 2020).

The types of plants found in Usada Taru Pramana are *taru* (trees), grasses, vines/creepers, and shrubs. Vines are all plants germinating in the ground and cannot mechanically support their stems without the help of external support (Sperotto et al., 2020). Vines are also widely used by the community for medicinal purposes (Kashung et al., 2020). The types of vines often listed as a medicine in the Lontar Usada Taru Pramana are fart leaves, cucumber, Javanese chili, green betel, clover, teleng flower, and gotu kola (Cahyaningrum & Ardhana, 2022). Knowledge of this kind of medicinal plants, which are commonly used by Balinese people, should be able to be maintained and preserved by future generations, one of which is by applying ethnochemistry learning in the classroom (Betaubun, 2020; Sutrisno et al., 2020).

Learning integrated with local culture as in ethnochemistry learning is supported by the policies of the Minister of Education and Culture related to the 2013 curriculum. The policy in the 2013 curriculum reveals that learning can be done through local content lessons to introduce students to their social, natural, and cultural environment (Rahmawati et al., 2020). Learning based on local wisdom is also following the new policy of the Minister of Education and Culture regarding the trial curriculum, the independent curriculum. The implementation of the independent curriculum is left to the respective regions and schools so that it can be adapted to the surrounding environmental conditions in each region. It has goals, including improving the quality of education in the regions by managing local wisdom and implementing education that is expected to be carried out evenly in remote areas (Hilmin et al., 2022).

Lontar Usada Taru Pramana focuses on traditional medicinal records made from herbal plants (Muderawan et al., 2020). Therefore, its implementation in learning activities requires a relevant approach since learning should practice scientifically explaining medicinal plants' use. Task-based learning can improve these skills (Murtiningrum et al., 2020). Task-based learning aims to use authentic language with the free and creative use of terms in all practical activities. This approach can undoubtedly highlight meaningful and student-centered communication (Sholeh, 2020; Toyoda et al., 2021). Task-based learning facilitates and encourages combining skills with daily life activities that can develop students' communicative skills, writing skills, problem-solving, and motivation (Chen & Wang, 2019; Coultas & Booth, 2019; Phetaree et al., 2020). This research supports the novelty that the meaningfulness of the chemical context can be achieved by students in order to understand the problem and be able to explain the solution scientifically. The topic applied can support the preservation of the local wisdom of Lontar Usada Taru Pramana in ethnochemistry learning. This research can answer the gaps in thinking skills and competency outcomes that are applied at the general and vocational school and high school levels. This study aims to analyze the effectiveness of task-based learning that utilizes the ethnochemistry potential of vines contained in Lontar Usada Taru Pramana, on students' scientific explanations skills.

METHODS

This research was The One-Group Pretest-Posttest Design (Ma et al., 2019). The one-group pre-test-post-test design does not use a control group as a comparison, pre-test scores and posttest scores will represent the level of ability achieved by participants at the end of the intervention, as well as the level of ability improvement during participation in the intervention (Alam, 2019; Ma et al., 2019; Siedlecki, 2020). This design is widely used to test the acquisition of knowledge after certain learning activities (Siedlecki, 2020). The design in this study was carried out by replication. This research focused on analyzing the effectiveness of the Task-Based Lontar Usada Taru Pramana on students' scientific explanation skills before and after participating in the Task-Based Lontar Usada Taru Pramana learning activities. The Task-Based Lontar Usada Taru Pramana is effective if it meets the minimum N-gain criteria in the moderate category.

The samples in this study were 234 high school students from two different schools, selected using a purposive sampling technique. The Task-Based Lontar Usada Taru Pramana (X1) was applied to two replication groups: Pharmacy Majoring Vocational Schools and Senior High Schools. Each group met statistically homogeneous requirements. Scientific versions of the Lontar Usada Taru Pramana booklet instruments, scientific explanation tests, and student response sheets supported the implementation of this research. The research was started by giving pre-task and pretest (O1) using take-home online. Students got an orientation to the task process through booklets. The learning activities carried out were by introducing students to Lontar Taru Pramana and various medicinal plants that are commonly found. Students were trained to explore various medicinal plants, describe their various ingredients and properties, and experiment with trying various ways of processing these medicinal plants (X1). Finally, after the entire teaching process was completed, all student groups were given a posttest (O2) and a review using take-home online. The scientific explanation of Lontar Taru Pramana written by students included several components: (1) plant classification, (2) chemical content, (3) benefits and how to mix it as medicine, and (4) a scientific version of Lontar Usada Taru Pramana composition.

Table 1. Scheme of Treatment on Samples

Class	Pretest	Treatment	Posttest
Replication	O1	X1	O2

A scale of 0-4 was used to assess students' scientific explanation skills of medicinal plants. Students get a score of 4 if they explain the scientific study of Lontar components comprehensively and precisely. If students explain the scientific study of the Lontar component incompletely but include the main points, they get a score of 3. Students get a score of 2 if they explain the scientific study of the Lontar component incompletely and do not include all the main points. Students score 1 if they explain an entirely irrelevant scientific study of Lontar components. A score of 0 is obtained if students do not explain anything in the Lontar components.

The improvement of students' scientific explanation skills was based on N-gain (posttest scores – pretest scores)/(4 – pretest scores) (Hake, 1998). The normality gain score was a technical analysis to determine the level of improvement in students' abilities (Sesmiyanti et al., 2019) in presenting scientific explanations before and after participating in the Usada Taru Pramana Task-Based Lontar learning activities. There are three improvement criteria based on the N-gain score obtained: (1) N-gain 0.70 (high); (2) .30 < N-gain < .70 (medium); and (3) N-gain 0.30 (low). The effectiveness of the Task-Based Lontar Usada Taru Pramana in increasing scientific explanation skills on medicinal plants was determined by pretest and posttest scores. The difference in the effectiveness of N-Gain in the scientific explanation skills of the vocational school and high school replication groups was analyzed using the Paired Sample T-test. Students' opinions about implementing the Task-Based Lontar Usada Taru Pramana were analyzed descriptively.

The pretest and posttest instruments were descriptive essay questions used to measure students' scientific explanation skills in some of the material in the Lontar Taru Pramana. Four question indicators in each part of the task were adjusted to the type of assignment in the Task-Based Lontar Usada Taru Pramana model. In completing the assignments, students had to go through the stages according to the type of assignment: (1) listing or making lists, where students shared their knowledge and experiences with colleagues and conduct fact searches by asking questions and referring to references, (2) sharing personal experiences, where students shared their experiences with colleagues to find solutions to problems in assignments, and (3) problem-solving, where students made hypotheses, described experiences, and compared alternative solutions to solve problems.

This research instrument's validity and reliability test used the SPSS application. The instrument is valid if the expert accepts the items in content and format without any revision. The reliability test used Cronbach's Alpha. The results are said to be reliable if $r > r_{table}$. The booklet as an instrument of the task process has proven its effectiveness. The questionnaire contained the difficulties students experience during learning.

The results of the validity and reliability tests of the pretest and posttest instruments are presented in Table 2. Based on the results, all 24 items of instruments were valid and reliable with Cronbach's Alpha = 0.62, indicating that the instrument used was included in the reliable category and the validity score was 0.75 which was also high, so they could be used in research. Items a, b, c, and d fulfilled the types of listing tasks, sharing personal experiences, and problem-solving with six different plant themes. The pretest and posttest questions were optional questions. Students had to complete 12 item questions and could choose three groups of questions to be answered.

Table 2. Validity and Reliability Test Results

Criteria	Number of Items	Total
Valid	1a, 1b, 1c, 1d, 2a, 2b, 2c, 2d, 3a, 3b, 3c, 3d, 4a, 4b, 4c, 4d, 5a, 5b, 5c, 5d, 6a, 6b, 6c, 6d	24
Invalid	-	0
Validity (Sig.)		0.75
Reliability (Cronbach's Alpha)		0.62
Total Item		24

RESULTS AND DISCUSSION

Table 3 shows the average N-gain for each class. Vocational high school students got an N-gain of 0.76, relatively larger than the N-gain of high school students, which was 0.72. Although there are differences, both are included in the same criteria, namely the high N-gain criterion. This indicates that there is an increase in students' ability to present scientific explanations after participating in the Lontar Usada Taru Pramana of Task-Based learning activities.

Table 3. N-gain of Vocational School and High School Students' Learning Outcomes

Class	Vocational School	High School
C1	0.77	0.73
C2	0.76	0.70
C3	0.76	0.71
C4	0.76	0.72
C5	0.77	0.72
Average	0.76	0.72

The percentage of N-gain for vocational school and high school students is shown in Figure 1. Vocational and high school students generally experienced higher scores in the high category. Vocational High School had more students who got N-gain in the high category (81%), while High School had more students who got N-gain in the moderate category (38%), as shown in Figure 1. This shows that all students, both from vocational school and high school, experience an increase in their ability to present scientific explanations of Lontar Usada Taru Pramana and the majority experience a significant increase.

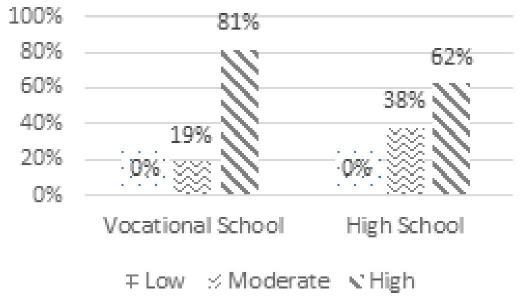


Figure 1. Percentage of N-gain for Vocational High School and High School Students

Learning outcomes increase due to the influence of the Task-Based Lontar Usada Taru Pramana on high school students who have the potential to activate their level of development. The characteristics of high school students are that they are at the stage of formal operational cognitive development, where students can think logically, think with formal theoretical thinking based on propositions and hypotheses, think using scientific reasoning, conclude from what is observed, accept other people's views, and think abstractly (Widodo et al., 2018; Ramadhani et al., 2019; Deshpande et al., 2022). At this stage, students' development increases very rapidly. Sometimes students can only develop the formal operational phase for a few fields, such as those with very good cognitive abilities in machinery and automotive but are not good enough in literature (Babakr et al., 2019).

The increase in students' ability to write scientific studies is in line with the results of previous research that ethnochemistry learning can train students' chemistry literacy skills (Imansari et al., 2018). This scientific literacy skill can be built through discovery, group discussion, debate, and assessment of the findings (Parmin & Khusniati, 2021). The results of other studies also show that ethnoscience-based learning can develop students' character and critical thinking skills and improve students' cognitive learning outcomes (Pu et al., 2019; Hikmawati et al., 2021).

Figure 2 shows that students have low-average scientific explanations before implementing Task-Based Lontar Usada Taru Pramana. Then there is a significant increase in the scientific explanations after being given treatment in the form of Task-Based Lontar Usada Taru Pramana learning. The pretest scores of vocational school and high school students are relatively the same (2.16 and 2.13). The posttest results yield a higher score than the pretest scores (3.56 and 3.47). Vocational high school students experience a slightly larger N-gain (0.76) than high school students (0.72).

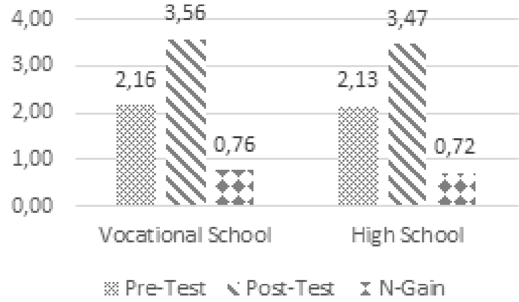


Figure 2. Average Pretest, Posttest, and N-gain Scores Obtained by High School and Vocational High School Students

Vocational high school students experience a relatively higher increase when compared to high school students. This is related to the suitability of medicinal plant material with basic pharmacognosy subjects in the pharmacy curriculum for vocational school majors, which are not taught to high school students. So, vocational school students tend to have better basic knowledge about medicinal plants compared to high school students. These students' initial knowledge is one factor that influences the learning process (Soltanpoor et al., 2018). Initial knowledge appropriate to learning material can reduce students' cognitive load in completing complex tasks with better final results (Zambrano et al., 2019; Antunes & Pinheiro, 2020; Brod, 2021).

The pretest on the ability to write explanations for scientific studies of medicinal plants based on lontar is carried out before implementing the Task-Based Lontar Usada Taru Pramana ethnochemistry learning model. Students are asked to explain the classification, content, benefits, and how to systematically, completely, and scientifically process three kinds of medicinal plants. Then students are asked to arrange these components according to the Lontar Usada Taru Pramana. The assignment in the Task-Based Lontar Usada Taru Pramana ethnochemistry learning model supports the process of scientific investigation, in which students are required to investigate the various contents and benefits of medicinal plants, then report them in systematic and scientific writing. In this case, students need to be conditioned to learn through a scientific process to develop their scientific attitude (Subagia & Wiratma, 2020). However, unfortunately, the results of pretests, both vocational and high school students, show that students still need to improve in compiling explanations of scientific studies.

The students' pretest results show that most students cannot write scientific explanations of medicinal plants. Students can explain the characteristics of plants in general. However, they have not been able to explain the details of the scientific classification of plants and their scientific names. Students have not been able to mention the various scientific ingredients in plants and need to be more precise in explaining how to concoct plants as medicine. The composition of Lontar written by students still needs to be more concise and scientific.

The ethnochemistry learning of the Task-Based Lontar Usada Taru Pramana model is carried out after the pretest. Learning is carried out online with the online system. Even though it is carried out online, if appropriate teaching materials support learning in tutorial activities, it can improve students' independent learning outcomes (Erlina et al., 2022). Interactive teaching materials accompany the implementation of learning following the material presented, namely regarding various medicinal plants integrated according to local Balinese culture, Lontar Usada Taru Pramana. Chemistry learning developed through local culture related to specific chemical phenomena, including lontar culture, will increase students' interest in learning chemistry and will be more easily understood by students (Dewi & Primayana, 2019; Zidny & Eilks, 2022). This ethnochemistry lesson provides an opportunity for students to learn more about science, culture, and society (Dewi et al., 2021), especially regarding the various properties of medicinal plants in Lontar Usada Taru Pramana. This learning can also direct students to meaningful learning and understanding to increase student competence and foster an appreciation for the knowledge and practices of their cultural background (Abumchukwu et al., 2021; Dewi et al., 2021).

The posttest results show differences in students' competency after learning ethnochemistry with the Task-Based Lontar Usada Taru Pramana model. In the posttest, most students have been able to explain the scientific study of medicinal plants more completely and systematically. They are more in line with the Lontar Usada Taru Pramana. Students can also explain the scientific classification of plants, explain various chemical constituents of plants even though they are not complete, write explanations of treatment recipes, and write scientific studies of plants based on Lontar Usada Taru Pramana.

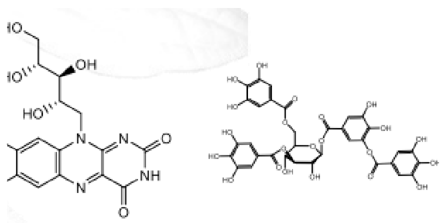
An example of an answer is given by student A with the highest N-gain. Student A can explain the scientific classification of betel leaves correctly and completely, along with pictures of betel leaves. In addition, student A also describes the various structures of the compounds in the betel leaf content completely. Concocting plants is also explained in detail and the additional materials needed. The results of the explanation of scientific studies based on the Lontar Usada Taru Pramana are very well written and complemented by processed products made from betel leaves.

Figure 3. Classification of Betel Leaf

Kingdom	:	Plantae
Divisio	:	Magnoliophyta
Sub-divisio	:	Angiospermae
Class	:	Magnoliopsida
Ordo	:	Piperales
Family	:	Piperaceae
Genus	:	Piper
Species	:	*Piper bettle L.*

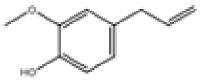
Betel leaf is a vine native to Indonesia. This plant has a height of 15 m with a leaf size of about 5-8 cm. Betel also has a round fruit that is grayish-green in color. Betel leaves are widely used to maintain healthy teeth and mouth.

Chemical components

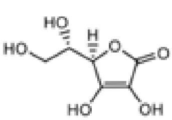


(a) Riboflavin **(b) Asam tanat**

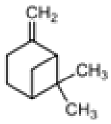
(c) β– sitosterol



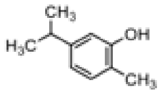
(d) Eugenol



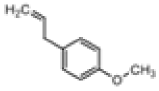
(e) Asam askorbat



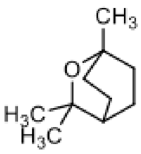
(f) β– pinena



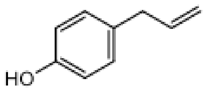
(g) Karvrakol



(h) Estragol

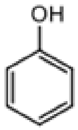


(i) 1,8-cineol

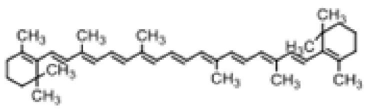


(j) Kavikol

(k) Borneol



(l) Asam fenolik



(m) β– karoten

Lontar Usada Taru Pramana Scientific Version

"My name is green betel (*Piper bettle L.*). My leaves contain phenol and chavicol, which are useful for helping to treat bad breath, strengthen and care for gums, teeth, and mouth, and can kill germs that cause plaque and reduce bleeding gums".

The hypothesis test used the T-Test, subject to normality conditions with Kolmogorov Smirnov. Hypothesis testing was used to determine the increase in students' scientific explanations by comparing the results of students' posttest and pretest. Before testing the hypothesis, a normality test was conducted first to determine whether the data obtained was normally distributed. The results of the prerequisite test and T-test are presented in Table 4 and Table 5.

Table 4. One-Sample Kolmogorov-Smirnov Test

	Vocational School	High School
N	117	117
Asymp. Sig. (2-tailed)	.200[c,d]	.091[c]

Based on the results of hypothesis testing, there is a significant difference between the pretest and posttest results. The task-based ethnochemistry learning of the Lontar Usada Taru Pramana model can improve students' scientific explanations based on the Lontar Usada Taru Pramana scientifically. Task-Based Lontar Usada Taru Pramana Learning for high school students has the potential to activate a linear level of student development with the ability to present scientific explanations in terms of logical thinking, presenting hypotheses, scientific reasoning, and making conclusions.

Table 5. T-Test

	Mean	Std. Error Mean	t	df	p
Vocational School – High School	.04667	.00741	6.294	116	<.01

It is consistent with the results of previous studies, which show that task-based learning can improve various skills, including students' writing, language, communication, and problem-solving skills (Azlan et al., 2019; Shenoy et al., 2021). Task-based online learning can provide flexibility in supporting students' reading literacy (Al-Kandari & Al-Qattan, 2020; Nguyen, 2022). Task-Based Lontar Usada Taru Pramana can activate students' interest in gathering information from various reading sources. The local wisdom contained in Lontar Usada Taru Pramana as an ethnoscience can build students' challenges to explore plants that students are already familiar with (Tresnawati & Siroj, 2021).

In addition to the pretest and posttest results, a survey was also conducted on the difficulties experienced by students. The questionnaire results show student interest in vines as a basic ingredient for medicine. The results of the questionnaire are presented in Table 6. The survey results also present the difficulties experienced by students. Students' difficulties are explored when completing task-based learning that involves students' scientific thinking and writing skills. The surveys ask which types of plants are difficult to explain, the most difficult parts of the test, and the reasons.

Table 6. Specialization Topic Vines

Topic	High School (%)	Vocational School (%)
Chili Java	24.55%	19.52%
Fart Leaf	9.58%	10.95%
Telang Flower	17.96%	18.10%
Gotu kola	4.79%	8.57%
Clover	19.16%	13.81%
Betel	23.95%	29.05%
Total	100.00%	100.00%

In addition, students are also asked about the reasons for choosing the topic and some of the obstacles they experience. Table 7 summarizes the majority of student answers. When students are asked to explain medicinal plants, they generally choose the type of plant they like or encounter before.

Table 7. Questionnaire Results of Difficulties Experienced by Students

Questions	Based on the posttest questions you have worked on, you are asked to choose three question numbers. Why do you choose these three types of plants?	You have mentioned the most difficult type of plant from the three question numbers. Why do you find it difficult?	Which part of the questions made it difficult for you (classification, chemical content, benefits and method of concoction, and composing the Scientific Version of Lontar Usada Taru Pramana)?
Answers	because I have seen it	I rarely see this plant	Chemical components
	Because it is efficacious/has many benefits	It is difficult to get information related to this plant	Classification
	Because I like/am interested in	The process is difficult	How to concoct
	Because it is easy to find references	There are no difficulties	Benefits
	Because it is often seen in the context of traditional medicines	Rarely used by the surrounding community	

Lontar Usada Taru Pramana supports a contextual approach to encourage students to explore the knowledge acquired in class and then relate it to real-life situations (Dewi & Primayana, 2019). Students' initial knowledge of various medicinal plants is essential to easily choosing plants that they will explain scientifically (Simonsmeier et al., 2022; Witherby & Carpenter, 2022). Students will tend to use existing knowledge to generate ideas in building new knowledge (Ward & Kolomyts, 2019). Scientific studies on cultural heritage add value to character education (Hermino & Arifin, 2020). In addition, students also choose plants based on the number of references available. Learning resources as a reference source plays an important role in the learning process and assist students in completing assignments independently (Bhat et al., 2022; Musaxonovna, 2022).

The response results also show that some students still have difficulty explaining medicinal plants scientifically. The challenge that students experience in general is when explaining the chemical content of plants, as well as how to concoct them into traditional medicine. This is because the number of references is small, so students have difficulty finding appropriate references. Public knowledge about medicinal plants is still limited, so many young people need to learn about the benefits of medicinal plants (Zubaidah et al., 2020; De Fretes & Rohayu, 2022). Another challenge for students is that they rarely find plants because the community rarely uses them, so students need to learn about the benefits they contain (Mekuria, 2018; Liu et al., 2020). Along with the times and increasing health services, people have turned a lot to medical treatment by using synthetic drugs, so people rarely do not even use medicinal plants (Hu et al., 2020; Nguyen et al., 2021).

CONCLUSION

The study shows that the task-based Lontar Usada Taru Pramana in ethnochemistry learning of vines can improve students' scientific explanation skills of medicinal plants based on Lontar Usada Taru Pramana scientifically through the stages of assignments in the form of listing, sharing, and problem-solving. During the lesson, students explain the scientific study of medicinal plants with several considerations on the types of plants that are already known and the ease of getting references. Even though students can explain the scientific study of medicinal plants well, students still experience difficulties when studying plants that are rarely used and need more references. Task-based Lontar Usada Taru Pramana learning is meaningful and supports the Balinese people's local wisdom. Through this learning, local wisdom in the form of Lontar Usada Taru Pramana can be passed on from generation to generation with the addition of scientific support. Furthermore, the task-based Lontar Usada Taru Pramana learning is expected to be a consideration for future chemistry learning curriculum policies.

ACKNOWLEDGEMENTS

The authors would like to thank various parties who have contributed to this research, especially the Research and Community Service Institute of Universitas Pendidikan Ganesha. This research is supported by DIPA BLU with the number SP DIPA – 403/UN48.16/LT/2021. The authors also thank the teachers and students of Kubu Supplement State Vocational High School and Undiksha Lab High School, who have actively supported the implementation of this research.

REFERENCES

Abumchukwu, A., Eke, J., J., A., & Anulika, J. (2021). Effects of Ethnochemistry instructional strategy on Secondary School Students' Achievement in Chemistry in Onitsha Education Zone. *African Journal of Science, Technology & Mathematics Education (AJSTME), 6*(1), 121-128.

Alam, T. G. M. R. (2019). Comparative analysis between pre-test/post-test model and post-test-only model in achieving the learning outcomes. *Pakistan Journal of Ophthalmology, 35*(1), 4-8.

Al Kandari, A. M., & Al Qattan, M. M. (2020). E-task-based learning approach to enhancing 21st-century learning outcomes. *International Journal of Instruction*, *13*(1), 551-566.

Antunes, H. D. J. G., & Pinheiro, P. G. (2020). Linking knowledge management, organizational learning and memory. *Journal of Innovation & Knowledge*, *5*(2), 140-149.

Arsa, D. M. S., Putri, G. A. A., Zen, R., & Bressan, S. (2020, November). Isolated Handwritten Balinese Character Recognition from Palm Leaf Manuscripts with Residual Convolutional Neural Networks. In *2020 12th International Conference on Knowledge and Systems Engineering (KSE)* (pp. 224-229). IEEE.

Azlan, N. A. B., Zakaria, S. B., & Yunus, M. M. (2019). Integrative task-based learning: Developing speaking skill and increase motivation via Instagram. *International Journal of Academic Research in Business and Social Sciences*, *9*(1), 620–636.

Babakr, Z., Mohamedamin, P., & Kakamad, K. (2019). Piaget's cognitive developmental theory: Critical review. *Education Quarterly Reviews, 2*(3), 65-76.

Betaubun, M. (2020). Improving Digital Learning Tool in the Classroom through Interactive Bilingual Ebook Based On Local Wisdom of Indonesia. *American Journal of Humanities and Social Sciences Research (AJHSSR), 4*(6), 292-302.

Bhat, G. M., Bhat, I. H., Shahdad, S., Rashid, S., Khan, M. A., & Patloo, A. A. (2022). Analysis of feasibility and acceptability of an e-learning module in anatomy. *Anatomical Sciences Education, 15*(2), 376-391.

Bhure, M., Welu, F., See, S., & Ota, M. K. (2021). The effort to enhance pupils cognitive learning achievement using contextual teaching and learning approach. *Journal of Research in Instructional, 1*(1), 13-22.

Brod, G. (2021). Toward an understanding of when prior knowledge helps or hinders learning. *Npj Science of Learning*, *6*(1), 1-3.

Budiman, A., Samani, M., & Setyawan, W. H. (2021). The development of direct-contextual learning: A new model on higher education. *International Journal of Higher Education*, *10*(2), 15-26.

Cahyaningrum, P. L., & Ardhana, İ. K. (2022). Traditional treatment of tuju disease (rheumatism) in lontar usada based on Bali local wisdom. *Journal of Economy Culture and Society*, *1*(1), 0-0.

Carmel, J. H., Herrington, D. G., Posey, L. A., Ward, J. S., Pollock, A. M., & Cooper, M. M. (2019). Helping students to "do science": Characterizing scientific practices in General Chemistry Laboratory Curricula. *Journal of Chemical Education*, *96*(3), 423-434.

Chen, S., & Wang, J. (2019). Effects of Task-Based Language Teaching (TBLT) approach and language assessment on students' competences in intensive reading course. *English Language Teaching*, *12*(3), 119–138.

Coultas, V., & Booth, P. (2019). Exploratory talk and task-based learning: A case study of a student's learning journey on an MA (education) English language teaching course. *Changing English*, *26*(1), 30–47.

De Fretes, E. D., & Rohayu, S. B. (2022). Pemanfaatan Tanaman Obat Keluarga Dalam Meningkatkan Imun Di Kelurahan Fakfak Selatan. *ABDIKAN: Jurnal Pengabdian Masyarakat Bidang Sains dan Teknologi*, *1*(3), 301-306.

Deschpande, G., Sharma, S., & Kulkarni, A. (2022). Review on the Use of Expert System in Cognitive Development of Children. *Asian Journal of Organic & Medicinal Chemistry, 7*(2), 143-147.

Dewi, P. Y. A., & Primayana, K. H. (2019). Effect of learning module with setting contextual teaching and learning to increase the understanding of concepts. *International Journal of Education and Learning, 1*(1), 19-26.

Dewi, C. C. A., Erna, M., Martini, Haris, I., & Kundera, I. N. (2021). The effect of contextual collaborative learning based Ethnoscience to increase student's scientific literacy ability. *Journal of Turkish Science Education*, *18*(3), 525-541.

Erlina, N., Prayekti, P., & Wicaksono, I. (2022). Atomic physics teaching materials in blended learning to improve self-directed learning skills in distance education. *Turkish Online Journal of Distance Education*, *23*(4), 20-38.

Ferreira, R. D., Naiman, W. M., & Techio, K. H. (2022). Etnoquímica na Educação Básica revisão bibliográfica sobre as produções no Brasil: Ethnochemistry in Basic Education: bibliographic review on productions in Brazil. *Revista Cocar*, *17*(35), 173-185.

Flynn, A. B., Orgill, M., Ho, F. M., York, S., Matlin, S. A., Constable, D. J. C., & Mahaffy, P. G. (2019). Future directions for systems thinking in Chemistry Education: Putting the pieces together. *Journal of Chemical Education*, *96*(12), 3000–3005.

Ginting, R. T., Dewi, A. S. S., Resen, P. T. K., & Samosir, F. T. (2021). Digitizing the Balinese Lontar Manuscript: A Case Study of Puri Kauhan Ubud, Bali. In *7th International Conference of Asian Special Libraries* (p. 108).

Hajian, S. (2019). Transfer of learning and teaching: A review of transfer theories and effective instructional practices. *IAFOR Journal of education, 7*(1), 93-111.

Hake, R. R. (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. *American journal of Physics, 66*(1), 64-74.

Heliawati, L., Lidiawati, L., Adriansyah, P. N. A., & Herlina, E. (2022). Ethnochemistry-based adobe flash learning media using indigenous knowledge to improve students' scientific literacy. *Jurnal Pendidikan IPA Indonesia*, *11*(2), 271-281.

Hermino, A., & Arifin, I. (2020). Contextual Character Education for Students in the Senior High School. *European Journal of Educational Research, 9*(3), 1009-1023.

Hikmawati, H., Gunawan, G., Sahidu, H., & Kosim, K. (2021). Effect of Local Culture Based Learning in Science on Critical Thinking and Student Communication Skills. *Journal of Science and Science Education*, *2*(1), 8-16.

Hilmin, H., Noviani, D., & Nafisah, A. (2022). Kebijakan Pemerintah Daerah dalam Penerapan Kurikulum Merdeka. *Jurnal Pendidikan dan Sosial Humaniora*, *2*(2), 148-162.

Hinzler, H. I. R. (1993). Balinese Palm-Leaf manuscripts. *Bijdragen Tot de Taal-, Land- En Volkenkunde*, *149*(3), 438–473.

Holme, T. (2019). Incorporating elements of green and sustainable chemistry in general chemistry via systems thinking. In *Integrating Green and Sustainable Chemistry Principles into Education* (pp. 31-47). Elsevier.

Hu, R., Lin, C., Xu, W., Liu, Y., & Long, C. (2020). Ethnobotanical study on medicinal plants used by Mulam people in Guangxi, China. *Journal of ethnobiology and ethnomedicine, 16*(1), 1-50.

Hyun, C. C., Wijayanti, L. M., Asbari, M., Purwanto, A., Santoso, P. B., Igak, W., ... & Pramono, R. (2020). Implementation of contextual teaching and learning (CTL) to improve the concept and practice of love for faith-learning integration. *International Journal of Control and Automation, 13*(1), 365-383.

Imansari, M., Sudarmin, S., & Sumarni, W. (2018). Analisis literasi kimia peserta didik melalui pembelajaran inkuiri terbimbing bermuatan etnosains. *Jurnal Inovasi Pendidikan Kimia*, *12*(2), 2201–2211.

Kangkhao, S., Louhapensang, C., & Noobanjong, K.

(2022, January). Expressions of Local Identity via Architectural Practice in UNESCO World Heritage Sites. In *Proceedings of 2021 4th International Conference on Civil Engineering and Architecture* (pp. 615-623). Singapore: Springer Nature Singapore.

Kashung, S., Gajurel, P. R., & Singh, B. (2020). Ethnobotanical uses and socio-economic importance of climbing species in Arunachal Pradesh, India. *Plant Science Today*, *7*(3), 371-377.

Kembara, M. D., Hanny, R., Gantina, N., Kusumawati, I., Budimansyah, D., Sunarsi, D., & Khoiri, A. (2020). Scientific literacy profile of student teachers on science for all context. *Solid State Technology, 63*(6), 5844-5856.

Kesiman, M. W. A. (2019). Word Recognition for the Balinese Palm Leaf Manuscripts. In *2019 IEEE International Conference on Cybernetics and Computational Intelligence (CyberneticsCom)* (pp. 72-76). IEEE.

Konyefa, B. I., & Okigbo, E. C. (2021). Effect of ethnochemistry instructional approach on secondary school students' achievement in chemistry in Bayelsa State. *International Journal of Education and Evaluation (IJEE)*, *7*(5), 1-11.

Lehtola, S., & Karttunen, A. J. (2022). Free and open source software for computational chemistry education. *Wiley Interdisciplinary Reviews: Computational Molecular Science*, *12*(5), e1610.

Liu, Y., Zhan, S. P., Song, L., Chen, Y., Jia, Y. T., Liu, F., ... & Xia, P. Y. (2020). Drug-induced liver injury: Clinical and etiologic features at a large tertiary teaching hospital in China. *Medical Science Monitor: International Medical Journal of Experimental and Clinical Research, 26,* e919435-1.

Ma, C. M., Shek, D. T., & Chen, J. M. (2019). Changes in the participants in a community-based positive youth development program in Hong Kong: Objective outcome evaluation using a one-group pretest-posttest design. *Applied Research in Quality of Life*, *14*, 961-979.

Mahaffy, P. G., Krief, A., Hopf, H., Mehta, G., & Matlin, S. A. (2018). Reorienting chemistry education through systems thinking. *Nature Reviews Chemistry*, *2*(4), 1-13.

Mediastari, A. A. P. A. (2020). Local wisdom traditional medicine for the health and beauty of postpartum mother in Denpasar City, Bali Province, Indonesia. *International Journal of Health and Medical Sciences, 3*(1), 65-71.

Mekuria, A. B., Belachew, S. A., Tegegn, H. G., Ali, D. S., Netere, A. K., Lemlemu, E., & Erku, D. A. (2018). Prevalence and correlates of herbal medicine use among type 2 diabetic patients in Teaching Hospital in Ethiopia: a cross-sectional study. *BMC complementary and alternative medicine, 18*(1), 1-8.

Muderawan, I. W., Budiawan, I. M., Giri, M. K. W., & Atmaja, I. N. B. (2020). Usada: The Ethnomedicine of Balinese Society. *International Journal of Ayurvedic and Herbal Medicine*, *10*(6), 3893–3905.

Munandar, R., Ristanti, C. I., Busyairi, A., & Rokhmat, J. (2022). Analisis potensi pembelajaran fisika berbasis etnosains untuk meningkatkan kecintaan budaya lokal masyarakat bima: pendidikan. *Jurnal Penelitian dan Pembelajaran Fisika Indonesia*, *4*(1).

Murtiningrum, R. C. R. D., Rafli, Z., & Purbaini, A. (2020). Application of the task-based learning method to improve English business letter writing skills. *Deiksis, 12*(02), 220-228.

Musaxonovna, K. L. (2022). General secondary schools requirements for the introduction of informed educational resources for the development of natural sciences. *Academicia: An International Multidisciplinary Research Journal, 12*(5), 855-860.

Musengimana, J., Kampire, E., & Ntawiha, P. (2021). Factors Affecting Secondary Schools Students' Attitudes toward Learning Chemistry: A Review of Literature. *EURASIA Journal of Mathematics, Science and Technology Education*, *17*(1), em1931.

Nguyen, P. H., De Tran, V., Pham, D. T., Dao, T. N. P., & Dewey, R. S. (2021). Use of and attitudes towards herbal medicine during the COVID-19 pandemic: a cross-sectional study in Vietnam. *European Journal of Integrative Medicine, 44*, 101328.

Nguyen, T. T. N. (2022). The effects of task-based instruction on reading comprehension of non-English major students at a university in the Mekong Delta. *International Journal of TESOL & Education, 2*(4), 1-20.

Obikezie, M. C., Abuchukwu, A. A., & Chikendu, R. E. (2021). Effect of Contextual Teaching-Learning Approach on Students' Retention in Chemistry in Secondary Schools in Anambra State. *International Journal of Trend in Scientific Research and Development (IJTSRD), 5*(3), 404.

Parmin, P., & Khusniati, M. (2021). The readiness of pre-service integrated science teachers toward the next generation science standards. *Jurnal Cakrawala Pendidikan, 40*(3), 713-724.

Parmiti, D. P., Rediani, N. N., Antara, I. G. W. S., & Jayadiningrat, M. G. (2021). The Effectiveness of Local Culture-Integrated Science Learning through Project-Based Assessment on Scientific Attitudes and Science Process Skills of Elementary School Students. *Jurnal Pendidikan IPA Indonesia, 10*(3), 439-446.

Srimunta, P., Suphandee, T., Senarat, S., Sripai, S., & Ardwichai, S. (2020). Development of the English Teaching Evaluation Model Focusing on Task-Based Learning to Develop English Writing Ability and Creative Thinking in Language for Sixth Grade Students in Thailand. *Educational Research and Reviews*, *15*(7), 377-384.

Pratiwi, V. U., & Suwandi, S. (2021). Local wisdom in the picture storybook for elementary school students in Sukoharjo regency. *Budapest International Research and Critics Institute (BIRCI-Journal): Humanities and Social Sciences, 4*(1), 1262-1271.

Pu, D., Ni, J., Song, D., Zhang, W., Wang, Y., Wu, L., Wang, X., & Wang, Y. (2019). Influence of critical thinking disposition on the learning efficiency of problem-based learning in undergraduate medical students. *BMC Medical Education*, *19*(1), 1-8.

Putra, I. B. G. K. (2020). Minister Terawan encourages Usadha Bali development under Traditional Balinese Medicine branding. *Bali Tourism Journal, 4*(1), 10-13.

Rahmawati, Y., Ridwan, A., & Hadinugrahaningsih, T. (2019). Developing critical and creative thinking skills through STEAM integration in chemistry learning. *In Journal of Physics: Conference Series* (Vol. 1156, No. 1, p. 012033). IOP Publishing.

Rahmawati, Y., Ridwan, A., Faustine, S., & Mawarni, P. C. (2020). Pengembangan soft skills siswa melalui penerapan culturally responsive transformative teaching (CRTT) dalam pembelajaran kimia. *Jurnal Penelitian Pendidikan IPA*, *6*(1), 86-96.

Ramadhani, R., Rofiqul, U. M. A. M., Abdurrahman, A., & Syazali, M. (2019). The effect of flipped-problem based learning model integrated with LMS-google classroom for senior high school students. *Journal for the Education of Gifted Young Scientists, 7*(2), 137-158.

Ramdani, A., Jufri, A. W., Gunawan, G., Fahrurrozi, M., & Yustiqvar, M. (2021). Analysis of students' critical thinking skills in terms of gender using science teaching materials based on the 5E learning cycle integrated with local wisdom. Jurnal Pendidikan IPA Indonesia, *10*(2), 187-199.

Ramdiah, S., Abidinsyah, A., Royani, M., Husamah, H., & Fauzi, A. (2020). South Kalimantan Local Wisdom-Based Biology Learning Model. *European Journal of Educational Research, 9*(2), 639-653.

Shwartz, G., Shav-Artza, O., & Dori, Y. J. (2021). Choosing chemistry at different education and career stages: Chemists, chemical engineers, and teachers. *Journal of Science Education and Technology, 30*(5), 692-705.

Sesmiyanti, S., Antika, R., & Suharni, S. (2019). N-Gain Algorithm for Analysis of Basic Reading. In *Proceedings of the 2nd International Conference on Language, Literature and Education, ICLLE 2019, 22-23 August, Padang, West Sumatra, Indonesia*.

Shenoy, R., Jain, A., K, B., Shirali, A., Shetty, S. B., & Ramakrishna, A. (2022). A task-based learning strategy in preclinical medical education. *Advances in Physiology Education*, *46*(1), 192–199.

Sholeh, M. B. (2020). Implementation of task-based learning in teaching English in Indonesia: Benefits and problems. *Language Circle: Journal of Language and Literature*, *15*(1), 1-9.

Siedlecki, S. L. (2020). Quasi-Experimental Research Designs. *Clinical Nurse Specialist, 34*(5), 198–202.

Simonsmeier, B. A., Flaig, M., Deiglmayr, A., Schalk, L., & Schneider, M. (2022). Domain-specific prior knowledge and learning: A meta-analysis. *Educational psychologist, 57*(1), 31-54.

Soltanpoor, R., Thevathayan, C., & D'Souza, D. (2018). Adaptive remediation for novice programmers through personalized prescriptive quizzes. In *Proceedings of the 23rd Annual ACM Conference on Innovation and Technology in Computer Science Education* (pp. 51-56).

Sperotto, P., Acevedo-Rodríguez, P., Vasconcelos, T. N. C., & Roque, N. (2020). Towards a standardization of terminology of the climbing habit in plants. *The Botanical Review*, *86*(3), 180–210.

Subagia, I. W., & Wiratma, I. G. L. (2020). The effectiveness of chemistry learning strategy in improving students' learning process and achievement. In *Journal of Physics: Conference Series* (Vol. 1567, No. 4, p. 042039). IOP Publishing.

Sudipa, I. G. I., Aditama, P. W., & Yanti, C. P. (2022). Developing Augmented Reality Lontar Prasi Bali as an E-learning Material to Preserve Balinese Culture. *Journal of Wireless Mobile Networks, Ubiquitous Computing, and Dependable Applications (JoWUA), 13*(4), 169-181.

Sutrisno, H., Wahyudiati, D., & Louise, I. S. Y. (2020). Ethnochemistry in the chemistry curriculum in higher education: exploring chemistry learning resources in sasak local wisdom. *Universal Journal of Educational Research, 8*(12A), 7833-7842.

Toyoda, J., Yashima, T., & Aubrey, S. (2021). Enhancing situational willingness to communicate in novice EFL learners through task-based learning. *JALT Journal*, *43*(2), 185-214.

Tresnawati, N., & Siroj, N. (2021). Skill dimension training for elementary school students through an ethnoscience-based Mangrove conservation literacy education program at Primary School 3 Ambulu, Cirebon Regency. *Abdimas Awang Long, 4*(1), 41-50.

Ugwu, A. N. (2020). Effects of ethno-chemistry-based curriculum delivery on students' interest in chemistry in Obollo-Afor Education Zone of Enugu State. *Journal of the Nigerian Academy of Education*, *14*(2), 11-24.

Ward, T. B., & Kolomyts, Y. (2019). Creative cognition. In The Cambridge handbook of creativity, 2nd ed (pp. 175–199). Cambridge University Press.

Widodo, S. A. (2018). Selection of learning media Mathematics for junior school students. *Turkish Online Journal of Educational Technology-TOJET, 17*(1), 154-160.

Witherby, A. E., & Carpenter, S. K. (2022). The rich-get-richer effect: Prior knowledge predicts new learning of domain-relevant information. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 48*(4), 483.

Wiyarsi, A., Pratomo, H., & Priyambodo, E. (2020). Vocational high school students' chemical literacy on context-based learning: a case of petroleum topic. *Journal of Turkish Science Education, 17*(1), 147-161.

Zambrano R., J., Kirschner, F., Sweller, J., & Kirschner, P. A. (2019). Effects of prior knowledge on collaborative and individual learning. *Learning and Instruction*, 63, 101214.

Zidny, R., & Eilks, I. (2022). Learning about Pesticide use adapted from Ethnoscience as a contribution to green and sustainable chemistry education. *Education Sciences*, *12*(4), 227-242.

Zubaidah, S., Azis, S., Mahanal, Susriyat, I., Batoro, J. A. T. I., & Sumitro, S. B. (2020). Local knowledge of traditional medicinal plants use and education system on their young of Ammatoa Kajang tribe in South Sulawesi, Indonesia. *Biodiversitas Journal of Biological Diversity, 21*(9), 3989-4002.