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ETHNOCHEMISTRY-BASED ADOBE FLASH LEARNING MEDIA USING INDIGENOUS KNOWLEDGE TO IMPROVE STUDENTS' SCIENTIFIC LITERACY

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ABSTRACT

This study aims to measure the effectiveness of using ethnochemistry-based Adobe Flash learning media using indigenous knowledge on scientific literacy. The study used a quasi-experimental method. The research subjects were 68 students who used ethnochemistry-based Adobe Flash learning media using indigenous knowledge on secondary metabolite material. The research is a quantitative study with pretest and posttest design. Data in the study were collected through tests to determine students' scientific literacy skills, including aspects of knowledge and competence in analyzing scientific phenomena, connecting chemical concepts to existing phenomena, and interpreting data or scientific evidence and questionnaires. Supporting data was obtained through a questionnaire to determine learning media users' opinions. The test was conducted with ten multiple-choice questions and a questionnaire with ten statements using a Likert scale of 1-4. The data analysis technique calculates the average score of test questions that have criteria according to scientific literacy and the percentage of user satisfaction. Based on the research results, the average value of 81.50 for scientific literacy skills on the concept of secondary metabolites with an N Gain of 80% is in a good category, and it is also known that the average percentage of user satisfaction is 83%, in a good category. Based on the hypothesis testing using the right-test, it has a t count of 16,160 and a t table of 2,021. The study concludes that applying ethnochemistry-based Adobe Flash learning media on secondary metabolites is effective for students' scientific literacy. Thus, it could be excluded that interactive media can support students' learning and improve scientific literacy.

Keywords: ethnochemistry; indigenous knowledge; scientific literacy

INTRODUCTION

Since the COVID-19 pandemic severely damaged many aspects of human life, including the economy, social, health, and education, the application of learning has opened a new era (Adedoyin & Soykan, 2020; Carrillo & Flores, 2020). The educational aspect has changed in the curriculum and the learning media. The usual offline learning in the classroom or the laboratory has turned into online learning following health protocols. This change eventually resulted in learning methods becoming more integrated with educational technology, such as electronic learning, mobile learning, and Android-based game learning (Saifi et al., 2020; William et al., 2021). Digital technology finally plays a vital role in enabling teachers to teach synchronously or asynchronously with online modes.

In the health aspect, a new phenomenon has emerged where people are trying to return to traditional medicine by utilizing various native

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natural ingredients in various countries (Muhammad, 2020), including Indonesia (Maharani & Fernandes, 2021). This phenomenon shows how important it is for the community to recognize and study natural materials rich in biodiversity in each region. One way to introduce these natural materials is to study indigenous knowledge, which is local people's knowledge, belief, and behavior through scientific understanding (Mazzocchi, 2020). The introduction of different indigenous knowledge in each region is essential for students to protect the culture and wealth of local wisdom for future generations (Parmin & Fibriana, 2019).

The indigenous knowledge approach can also be applied in ethnomedical and ethnochemistry research (Anulika, 2021; Bradley, 2021). Ethnochemistry, part of ethnoscience, is a cultural perspective from a scientific perspective (Dewi et al., 2019) and a specific cultural behavior related to chemistry (Rosa & Clark, 2011). Ethnochemistry and ethnoscience are integrated into educational curricula in various countries with the hope that students can develop new opportunities and innovations in using indigenous knowledge as regional cultural identities (Victor et al., 2016). Previous research on ethnochemistry was conducted to identify the local wisdom of the Sasak tribe in West Lombok (Sutrisno et al., 2020), explore the potential of native Kalimantan herbal medicines for body immunity (Maharani & Fernandes, 2021), and find out the use of the Gewang plant (*Corypha utan Lamk*) in East Nusa Tenggara which is commonly used for its seed extract as a fish poisoning by local people it has potential as an anti-cancer drug (Heliawati et al., 2015). The existence of various information in various media today requires students to have the skills to respond, think critically and creatively, and have sufficient knowledge to be mastered through students' scientific literacy skills.

Scientific literacy is an understanding or knowledge of scientific concepts and processes that individuals need, especially when making decisions, contributing in social and economic terms with problem-solving skills (Spitzer & Fraser, 2020; Dewi et al., 2021; Prasetia & Adlan, 2022). According to Woodin et al. (2010), students with good scientific literacy skills will have several characteristics: better understanding of scientific processes and their application in society, competence in communicating and collaborating, skills in interpreting data, and skills in modeling or simulation related to the field of computerization. These student characteristics can be obtained through digital technology such as multimedia (Ahied et al., 2020; Widodo et al., 2020; Taitingfong & Ullah, 2021; Isnaeni et al., 2021)

Multimedia is one of the alternative learning media, especially during a pandemic. It can integrate experimental simulations with interactive animations and videos. The choice of the most supportive software as an alternative to making interactive learning media is Adobe Flash CS 6 (Sheeba & Begum, 2018; Purba et al., 2021). Applications made with Adobe Flash CS 6 have the advantage of presenting animations in motion, images, and sounds like interactive multimedia (Saputro et al., 2018; Siburian et al., 2020). Adobe Flash CS software has all the multimedia elements needed to create an application with simulations that describe natural phenomena and a chemical process so that the concept of ethnochemistry will be easier to understand (Sukariasih et al., 2019). Multimedia from Adobe Flash will increase students' learning interest to support the online chemistry learning process.

Before the pandemic, a practicum on secondary metabolites was carried out in a physical laboratory using an isolation method consisting of extraction, fractionation, and purification. Learning chemistry courses so far is more appropriate through the practicum method because this method requires students to understand the concept and solve the existing problems (Parmin et al., 2017; Hakim et al., 2020). This practicum costs a lot because the tools are not available, and the materials needed are expensive. During the pandemic, natural material chemistry learning faced obstacles when students could not carry out practicum in the laboratory. Based on the preliminary study results, these obstacles cause problems that impact the lack of students' scientific literacy skills by 60% based on the preliminary study results. There is a need for innovation in making interactive multimedia so that learning runs optimally even though it is done online.

Various innovations in digital technology that are developing more rapidly during the pandemic encourage educators to plan innovative and creative learning strategies by choosing suitable media (Mailizar et al., 2021; Krouska et al., 2021; Lin et al., 2021; Pebriani, 2022). Learning media suitable for the characteristics of secondary metabolites is a virtual laboratory simulation as one of the essential components of the e-learning system (Rowe et al., 2018; Eljack et al., 2020). Digital-based learning media should meet the criteria in the guidelines for technology assessment which include: the quality of objectives and content, relating to the elements of accuracy and suita-

bility of students' conditions, instructional quality, through increased motivation, the nature of instructional flexibility, instructional social quality, quality of tests and assessment evaluations and technical quality which includes aspects of readability, ease of use, and quality of media design (Azhar, 2011; Martin & Betrus, 2019).

This study aims to measure students' scientific literacy skills after using ethnochemistry-based Adobe Flash multimedia in secondary metabolite learning. This material requires presentation with the Adobe Flash program because it can provide the virtual laboratory needed to support successful learning by making it easier for students to learn the material. The criteria for scientific literacy skills in this study were that students could work on ten multiple-choice questions that met the criteria for higher-order thinking. The result of this study is an application of ethnochemistry-based Adobe Flash learning media using indigenous knowledge as an innovation for developing online teaching materials. The ethnochemistry-based Adobe Flash has steps of determining the ethnochemistry concept, built by design, collecting enough material, getting assembly, validation through testing, and distribution as learning media. This application can be accessed through a computer and downloaded via the link shared on the android device.

METHODS

This research method is quasi-experimental, referring to Creswell (2009). The research was conducted on several students taking natural materials chemistry courses. The ethnochemistry approach to secondary metabolites was chosen so that students can apply biodiversity as a source of secondary metabolites producing natural compounds in Indonesia, for example, the Gewang plant (*Corypha utan Lamk*) that grows in the savanna of East Nusa Tenggara. This plant is commonly used for fish poisoning by indigenous-people in East Nusa Tenggara and can be used for cancer treatment. This study used an experimental group with a particular treatment and a control group that external variables cannot fully control.

The research used a non-equivalent control group design with a pretest-posttest control group design technique (Cohen et al., 2000). Respondents were divided into experimental and control groups. The population in the study was 306 students majoring in chemistry, while the research sample was 68 students from two different groups. The sampling technique was purposive sampling type. The researcher randomly chose two groups and gave a pretest question to determine the difference between the experimental and control groups in the initial conditions. The pretest results are considered good if there is no significant difference between the experimental and control groups. The test is ten multiple-choice questions oriented to scientific literacy, including the cognitive level of applying (C3) and analyzing (C4). The questions given refer to the following criteria: (1) the provision of data in the form of graphs and articles on the use of Gewang, (2) an analysis of environmental problems related to the use of Gewang as fish poisoning, (3) interactive questions related to environmental issues and traditional local technology in West Lombok. Scientific literacy questions went through validity and reliability tests before being given to students.

The following research stage is treating the experimental group using learning mulitmedia, made from Adobe Flash based on ethnochemistry using indigenous knowledge material. The conventional learning using the learning media based on Microsoft PowerPoint in the control group. The posttest was given to the experimental group and the control group in the final stage to prove the impact of using multimedia on increasing scientific literacy. The research design is in Table 1.

Table 1. Research Design

Group	Pre-test	Treat-ment	Post-test
Experimental	O1	X	O2
Control	O3	C	O4

(Cohen et al., 2000)

Experimental Group: O1 (Giving a test before using Adobe Flash multimedia based on ethnochemistry using Indigenous knowledge); O2 (Giving a test after the treatment of ethnochemistry-based Adobe Flash multimedia using Indigenous knowledge); and X (Adobe Flash treatment based on ethnochemistry using Indigenous knowledge). Control Group: O3 (Providing a test before conventional learning); O4 (Giving a test after conventional learning); and C (Conventional learning without special treatment).

Quantitative data were obtained after giving scientific literacy tests and questionnaires to determine students' responses to ethnochemistry-based Adobe Flash multimedia using indigenous

knowledge. This study used a scientific literacy instrument consisting of 10 questions that include four indicators of scientific literacy skills, referring to Chiappetta et al. (1991). The instrument was then processed by giving a scale of 0 for the wrong answer and 1 for the correct answer. The multiple-choice content outline of scientific literacy skills is in Table 2.

Table 2. Indicators of Scientific Literacy Questions

Indicators of Scientific Literacy	Sub-indicator of question
Science as a Body of Knowledge	A picture is presented, and students can determine the right concepts and facts related to ethnochemistry.
Science as Ways of Investigation	Various case examples are given, and students can provide reasons for each answer.
Science as Ways of Thinking	A problem is presented, and students can conclude based on valid information.
Interactions between Science, Technology, and Society	Various cases related to using Gewang plants are given, and students can provide appropriate answers to the context of problems related to indigenous knowledge.

The research data were taken twice at the pretest and posttest. The data was processed by calculating N-gain and interpreted in several categories. The results are then analyzed as a unified whole in each indicator. The results of N-Gain were analyzed through categorization based on Hake (1999). The categories obtained generally describe the increased scientific literacy after treatment with ethnochemistry-based Adobe Flash using indigenous knowledge. The scientific literacy ability data is then processed by determining the percentage score of the division between the acquisition score and the maximum score in Table 3, referring to Yusuf (2014).

Table 3. Category of Scientific Literacy Percentage

Interpretation (%)	Category
$81{,}26 < X \leq 100$	Very high
$71{,}26 < X \leq 81{,}25$	High
$62{,}51 < X \leq 71{,}25$	Moderate
$43{,}76 < X \leq 62{,}50$	Low
$0 < X \leq 43{,}75$	Very low

Collection of response data of the use of ethnochemistry-based Adobe Flash multimedia using Indigenous knowledge refers to a Likert scale with four alternative answers. A score of 4 means strongly disagree, a score of 3 means disagree, a score of 2 means agree, and a score of 1 means strongly agree. The scientific literacy instrument was tested for validity and reliability before being applied to research. Based on the validity and reliability test, the validity of all instrument items was decided with a reliability coefficient of 0.833. The Cronbach Alpha value reaches > 0.60, so all items are considered reliable or consistent, and this research instrument is valid (Sujarweni, 2015). The next stage is the normality test of the pretest and posttest scores to determine the normality of the data distribution using the Kolmogorov Smirnov SPSS version 26.0 test.

The data is normally distributed at the value of = 0.05 if it is under the provisions of the Asymp value. Sig (2 tailed) > 0.05. If the value shows that it is normally distributed, then the independence sample t-test is performed so that there is evidence of a significant difference between the results of the pretest and posttest. The next step can be decided based on the value results, Sig. (2-tailed) $p < 0.05$, which indicated a significant difference between the two. When the value of Sig. (2-tailed) obtained $p > 0.05$, then there is no significant difference. The N-Gain test is carried out if the research data is normally distributed.

The effectiveness of using ethnochemistry-based Adobe Flash multimedia using Indigenous knowledge can be seen in the increasing pretest and posttest scores (N-Gain score). Ethnochemistry-based Adobe Flash multimedia using Indigenous knowledge will be declared effective if the N Gain score is 0.3 in the moderate or high category. Table 4 refers to Hake (1999).

Table 4. N-Gain Category

N Gain (%)	Interpretation
$(g) \geq 70$	High
$30 \leq (g) < 70$	Moderate
$(g) < 30$	Low

RESULTS AND DISCUSSION

Experts and lecturers have validated the development of ethnochemistry-based Adobe Flash learning media using indigenous knowledge on secondary metabolite material. Multimedia is an application that can be downloaded via Android or laptop. This multimedia is divided into three sections: introduction, content, and evaluation. The appearance of the introduction section in multimedia is presented in Figure 1.

Figure 1. Introduction of Ethnochemistry-based Adobe Flash Multimedia (Heliawati, 2021)

The specifications for ethnochemistry-based Adobe Flash learning media compared to printed learning media are in Table 5.

Table 5. Specification Comparison of Ethnochemistry-based Adobe Flash Multimedia using Indigenous knowledge

Aspect	Ethnochemistry-based Adobe Flash Multimedia using Indigenous knowledge	Printed Learning Media
Duration	According to individual learning speed	No duration
Efficiency	Multimedia can be published online or offline as an Android application, CD, word processing, web, or Learning Management System	The cost to print a book is expensive
Flexibility	Multimedia can be used for learning without being limited by place and time	Printed media tends to be cumbersome to carry
Feedback	Exercise with direct feedback can provide learning motivation	There is only one-way feedback and no interaction
Ease of Use	Using multimedia on smartphones or laptops is relatively easy and does not require certain smartphone specifications.	Printed media is hard to obtain, especially during online learning.
Audio Visual	The visualization is fascinating and suitable for use by students with visual and auditory learning types	Less able to meet the needs of students with visual and auditory learning types
Scientific Literacy Learning	The learning is constructivism. Students build their knowledge through virtual laboratories and videos.	The available information tends to be factual.
Learning Evaluation	The evaluation results are immediately obtained at the end of the third part (closing).	Students cannot obtain the results directly

The validation of ethnochemistry-based Adobe Flash multimedia using indigenous knowledge by lecturers includes four aspects: software engineering, audio communication, visual communication, and presentation materials. The results of the validation carried out are shown in Figure 2.

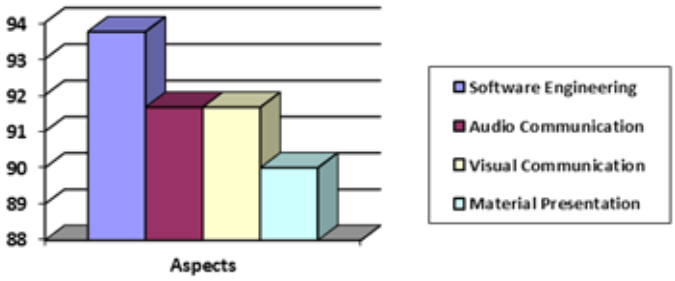

Figure 2. Validation Results of Ethnochemistry-based Multimedia using Indigenous knowledge

In Figure 2, the validity of ethnochemistry-based multimedia using indigenous knowledge from two lecturers as experts has the highest percentage in the software engineering aspect (93.75%), followed by audio communication and visual communication aspects with the same score (91.67%). The lowest aspect (90%) is in the presentation material aspect. The validator generally considers this multimedia appropriate as teaching materials in universities.

Based on the analysis of student responses regarding ethnochemistry-based multimedia using indigenous knowledge, this media is considered to make an essential contribution as an alternative to chemistry learning on secondary metabolites.

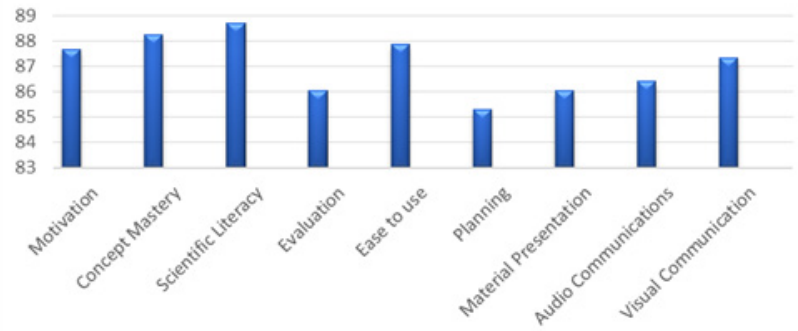

Figure 3. Students' Responses to the Use of Ethnochemistry-based Multimedia

The percentage of students' responses to the use of ethnochemistry-based Adobe Flash learning media using indigenous knowledge in Figure 3 shows an increase in learning motivation (87.68%), with attractively designed teaching media, but still easy to understand so that the evaluation results showed an increase (86.03%). Students can check their level of scientific literacy skills once they have finished working on the questions. Online learning that uses an ethnochemistry approach using indigenous knowledge improves scientific literacy skills (88.69%) and concept mastery of secondary metabolites (88.24%). In the media aspect, students assume that ethnochemistry-based Adobe Flash multimedia using indigenous knowledge is a learning medium with the selection of a suitable virtual laboratory and video (87.32%). Narrative delivery follows the learning theme (86.40%) so that it is easier for students to plan their learning (85.29%) because the characteristics of this multimedia are easy to use (87.87%). From the research on 22 male and 46 female students in the experimental and control groups, there were differences in the results of the pretest and posttest (Table 6).

Table 6. N-Gain Descriptive Statistical Score

	Experimental Group			Control Group		
	Pretest	**Posttest**	**N-Gain**	**Pretest**	**Posttest**	**N-Gain**
Minimum	20	60	-	20	50	-
Maximum	60	100	-	70	100	-
Average	40,29	83,82	0,72	39,71	74,71	0,57

Table 6 shows that the minimum score of students in the experimental group at the pretest was 20, and the posttest was 60. The maximum score at the pretest was 60, and the posttest was 100. This score shows that the average score at the posttest is 83.82, much higher than the average score at the pretest (40.29) and the acquisition of N-Gain scores (0.72 in the high category). The difference in the results was also shown in the control group. The minimum and maximum scores at the pretest were almost identical to those in the experimental group (20 and 70). However, the posttest results showed a minimum score of 50 and a maximum of 100. It was accompanied by an N-Gain score (0 .57 in the medium category). The difference in N-Gain score between the experimental and control groups was then tested for normality by the Kolmogorov-Smirnov test. The experimental and control groups showed the results of the normality test score reaching Sig. 0.200 > 0.05. This result means that the research data is normally distributed. An independent t-test was carried out, as shown in Table 7, to determine the effect of ethnochemistry-based Adobe Flash multimedia using indigenous knowledge, which has significant effectiveness.

Table 7. Results of the Independent T-Test on N-Gain

Levene's Test for Equality of Variances			**t-test for Equality of Means**		
	F	**Sig**	**t**	**df**	**Sig. (2-tailed)**
Equal variances assumed	0.630	0.430	-2.837	66	0.006
Equal variances assumed			-2.837	64,629	0.006

Table 7 shows that the significance value (Sig) on the Levene Test for Equality of Variances is 0.430 > 0.05, so the variance in the N-Gain data (%) in the experimental group and the control group is homogeneous. Value of Sig. (2-tailed) obtained is 0.006 < 0.05, so there is a significant difference in effectiveness in the treatment with ethnochemistry-based Adobe Flash multimedia using indigenous knowledge against the control group. The results of the analysis of the provision of scientific literacy-oriented multiple-choice questions during the posttest in the control and the experimental groups obtained different percentages for each scientific literacy indicator, referring to Chiappetta and Fillman (2007) as in Figure 4.

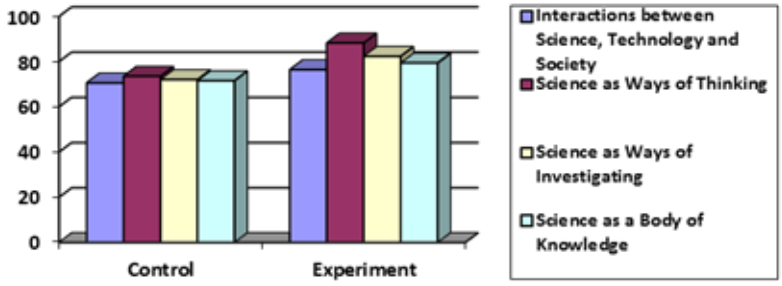

Figure 4. Comparison of Achievement of Scientific Literacy Indicators between Two Groups

The achievement of scientific literacy in Figure 4 shows that the experimental group has a higher average score on all indicators than the control group. On the indicators, Science as Ways of Thinking (88.24%), Science as Ways of Investigating (82.35%), Science as a Body of Knowledge (79.41%), and the lowest indicator is the Interactions between Science, Technology, and Society (76.47%). In the control group, the highest indicator was also obtained in the Science Ways of thinking (73.53%), Science as Ways of Investigating (72.06%), Science as a Body of Knowledge (71.57%), and the lowest indicator is Interactions between Science, Technology, and Society (70.59%).

The most significant increase in scientific literacy skills was achieved on the Science as Ways of the Thinking indicator. This aspect focuses on thinking, concluding, and reflecting on experiments through simulations in virtual laboratories. This interactive simulation has five instructional design principles, including guided

activities (instruction guides), reflection, direct feedback, freedom to explore, and pre-training (Miyamoto et al., 2019). A virtual laboratory has more advantages than a laboratory practicum on secondary metabolite material because it is a learning media that prioritizes user safety (Kapilan et al., 2021) and high efficiency (Faour et al., 2018; Asrizal et al., 2022).

The Science as a Way of Investigating indicator received the second largest percentage. This indicator is where students can solve problems in the form of scientific literacy questions according to the criteria for higher-order thinking skills in pictures or tables. Students in the experimental group are better able to solve problems related to scientific literacy because, in ethnochemistry-based Adobe Flash multimedia, there is a virtual laboratory simulation of secondary metabolites. This finding is reinforced by previous research on virtual laboratory simulations, which are proven to improve students' scientific literacy, especially in the ability to apply scientific concepts in everyday life. (Bortnik et al., 2017; Putri et al., 2021). Students' skills in applying the concept of secondary metabolites using indigenous knowledge will affect their quality of life.

The third-largest percentage is the Science as Body of Knowledge indicator, which includes information, facts, concepts, principles, laws, and theories in ethnochemistry-based Adobe Flash multimedia using indigenous knowledge. Learning materials in the context of indigenous knowledge help students achieve their purposes and more understand real-life scientific principles (Saija et al., 2022). The material is presented in written or video form that the user quickly understands. Another advantage of using video is that it allows users to watch it repeatedly at an unspecified time (Danjou, 2020). Students can better understand the provided material, so there will be no misconceptions (Rubini et al., 2018; Wargadinata et al., 2020). The video about secondary metabolites embedded in this multimedia comes from the Youtube channel, which is proven to present various scientific facts in an informative way (Rosenthal, 2018). After watching the video, students can freely collaborate and express their opinions in scientific discussions (Ndihokubwayo et al., 2020).

The lowest percentage is the indicator of Interaction between Science, Technology, and Society. This indicator relates to applying ethnochemistry to secondary metabolites in the context of indigenous knowledge issues in East Nusa Tenggara. Other research by Nisa et al. (2021) revealed that the same thing was caused by the material regarding ethnochemistry associated with the technology of the people of East Nusa Tenggara, which was not well known by respondents from the local area of West Java. The material about the Gewang plant (*Corypha utan Lamk*), commonly used for fish poisoning by the people in East Nusa Tenggara, has other medical technology benefits such as an anti-cancer or others (Heliawati et al., 2015; Hilaria & Octavia, 2020; Lazarus & Lawa, 2022). It opens students' insight, especially in ethnochemistry, to improve.

CONCLUSION

The students' scientific literacy skills were significantly obtained in the experimental group compared to the control group. The use of various elements in multimedia, such as virtual laboratory, videos, and interactive questions with direct feedback, has been shown to improve scientific literacy skills on secondary metabolite materials using the indigenous knowledge approach of the people of East Nusa Tenggara. Using ethnochemistry-based Adobe Flash multimedia, learning materials that explore the potential of Gewang (*Corypha utan Lamk*) seed extract as an anti-cancer open students' insight into the importance of recognizing the benefits of various biodiversity in Indonesia. This research is expected to encourage discoveries by utilizing natural ingredients native to Indonesia in health and other fields.

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Ethnochemistry-based Adobe Flash Learning Media Using Indigenous Knowledge to Improve Students' Scientific Literacy

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ETHNOCHEMISTRY-BASED ADOBE FLASH LEARNING MEDIA USING INDIGENOUS KNOWLEDGE TO IMPROVE STUDENTS' SCIENTIFIC LITERACY

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ABSTRACT

This study aims to measure the effectiveness of using ethnochemistry-based Adobe Flash learning media using indigenous knowledge on scientific literacy. The study used a quasi-experimental method. The research subjects were 68 students who used ethnochemistry-based Adobe Flash learning media using indigenous knowledge on secondary metabolite material. The research is a quantitative study with pretest and posttest design. Data in the study were collected through tests to determine students' scientific literacy skills, including aspects of knowledge and competence in analyzing scientific phenomena, connecting chemical concepts to existing phenomena, and interpreting data or scientific evidence and questionnaires. Supporting data was obtained through a questionnaire to determine learning media users' opinions. The test was conducted with ten multiple-choice questions and a questionnaire with ten statements using a Likert scale of 1-4. The data analysis technique calculates the average score of test questions that have criteria according to scientific literacy and the percentage of user satisfaction. Based on the research results, the average value of 81.50 for scientific literacy skills on the concept of secondary metabolites with an N Gain of 80% is in a good category, and it is also known that the average percentage of user satisfaction is 83%, in a good category. Based on the hypothesis testing using the right-test, it has a t count of 16,160 and a t table of 2,021. The study concludes that applying ethnochemistry-based Adobe Flash learning media on secondary metabolites is effective for students' scientific literacy. Thus, it could be excluded that interactive media can support students' learning and improve scientific literacy.

Keywords: ethnochemistry; indigenous knowledge; scientific literacy

INTRODUCTION

Since the COVID-19 pandemic severely damaged many aspects of human life, including the economy, social, health, and education, the application of learning has opened a new era (Adedoyin & Soykan, 2020; Carrillo & Flores, 2020). The educational aspect has changed in the curriculum and the learning media. The usual offline learning in the classroom or the laboratory has turned into online learning following health protocols. This change eventually resulted in learning methods becoming more integrated with educational technology, such as electronic learning, mobile learning, and Android-based game learning (Saifi et al., 2020; William et al., 2021). Digital technology finally plays a vital role in enabling teachers to teach synchronously or asynchronously with online modes.

In the health aspect, a new phenomenon has emerged where people are trying to return to traditional medicine by utilizing various native

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natural ingredients in various countries (Muhammad, 2020), including Indonesia (Maharani & Fernandes, 2021). This phenomenon shows how important it is for the community to recognize and study natural materials rich in biodiversity in each region. One way to introduce these natural materials is to study indigenous knowledge, which is local people's knowledge, belief, and behavior through scientific understanding (Mazzocchi, 2020). The introduction of different indigenous knowledge in each region is essential for students to protect the culture and wealth of local wisdom for future generations (Parmin & Fibriana, 2019).

The indigenous knowledge approach can also be applied in ethnomedical and ethnochemistry research (Anulika, 2021; Bradley, 2021). Ethnochemistry, part of ethnoscience, is a cultural perspective from a scientific perspective (Dewi et al., 2019) and a specific cultural behavior related to chemistry (Rosa & Clark, 2011). Ethnochemistry and ethnoscience are integrated into educational curricula in various countries with the hope that students can develop new opportunities and innovations in using indigenous knowledge as regional cultural identities (Victor et al., 2016). Previous research on ethnochemistry was conducted to identify the local wisdom of the Sasak tribe in West Lombok (Sutrisno et al., 2020), explore the potential of native Kalimantan herbal medicines for body immunity (Maharani & Fernandes, 2021), and find out the use of the Gewang plant (*Corypha utan Lamk*) in East Nusa Tenggara which is commonly used for its seed extract as a fish poisoning by local people it has potential as an anti-cancer drug (Heliawati et al., 2015). The existence of various information in various media today requires students to have the skills to respond, think critically and creatively, and have sufficient knowledge to be mastered through students' scientific literacy skills.

Scientific literacy is an understanding or knowledge of scientific concepts and processes that individuals need, especially when making decisions, contributing in social and economic terms with problem-solving skills (Spitzer & Fraser, 2020; Dewi et al., 2021; Prasetia & Adlan, 2022). According to Woodin et al. (2010), students with good scientific literacy skills will have several characteristics: better understanding of scientific processes and their application in society, competence in communicating and collaborating, skills in interpreting data, and skills in modeling or simulation related to the field of computerization. These student characteristics can be obtained through digital technology such as multimedia (Ahied et al., 2020; Widodo et al., 2020; Taitingfong & Ullah, 2021; Isnaeni et al., 2021)

Multimedia is one of the alternative learning media, especially during a pandemic. It can integrate experimental simulations with interactive animations and videos. The choice of the most supportive software as an alternative to making interactive learning media is Adobe Flash CS 6 (Sheeba & Begum, 2018; Purba et al., 2021). Applications made with Adobe Flash CS 6 have the advantage of presenting animations in motion, images, and sounds like interactive multimedia (Saputro et al., 2018; Siburian et al., 2020). Adobe Flash CS software has all the multimedia elements needed to create an application with simulations that describe natural phenomena and a chemical process so that the concept of ethnochemistry will be easier to understand (Sukariasih et al., 2019). Multimedia from Adobe Flash will increase students' learning interest to support the online chemistry learning process.

Before the pandemic, a practicum on secondary metabolites was carried out in a physical laboratory using an isolation method consisting of extraction, fractionation, and purification. Learning chemistry courses so far is more appropriate through the practicum method because this method requires students to understand the concept and solve the existing problems (Parmin et al., 2017; Hakim et al., 2020). This practicum costs a lot because the tools are not available, and the materials needed are expensive. During the pandemic, natural material chemistry learning faced obstacles when students could not carry out practicum in the laboratory. Based on the preliminary study results, these obstacles cause problems that impact the lack of students' scientific literacy skills by 60% based on the preliminary study results. There is a need for innovation in making interactive multimedia so that learning runs optimally even though it is done online.

Various innovations in digital technology that are developing more rapidly during the pandemic encourage educators to plan innovative and creative learning strategies by choosing suitable media (Mailizar et al., 2021; Krouska et al., 2021; Lin et al., 2021; Pebriani, 2022). Learning media suitable for the characteristics of secondary metabolites is a virtual laboratory simulation as one of the essential components of the e-learning system (Rowe et al., 2018; Eljack et al., 2020). Digital-based learning media should meet the criteria in the guidelines for technology assessment which include: the quality of objectives and content, relating to the elements of accuracy and suita-

bility of students' conditions, instructional quality, through increased motivation, the nature of instructional flexibility, instructional social quality, quality of tests and assessment evaluations and technical quality which includes aspects of readability, ease of use, and quality of media design (Azhar, 2011; Martin & Betrus, 2019).

This study aims to measure students' scientific literacy skills after using ethnochemistry-based Adobe Flash multimedia in secondary metabolite learning. This material requires presentation with the Adobe Flash program because it can provide the virtual laboratory needed to support successful learning by making it easier for students to learn the material. The criteria for scientific literacy skills in this study were that students could work on ten multiple-choice questions that met the criteria for higher-order thinking. The result of this study is an application of ethnochemistry-based Adobe Flash learning media using indigenous knowledge as an innovation for developing online teaching materials. The ethnochemistry-based Adobe Flash has steps of determining the ethnochemistry concept, built by design, collecting enough material, getting assembly, validation through testing, and distribution as learning media. This application can be accessed through a computer and downloaded via the link shared on the android device.

METHODS

This research method is quasi-experimental, referring to Creswell (2009). The research was conducted on several students taking natural materials chemistry courses. The ethnochemistry approach to secondary metabolites was chosen so that students can apply biodiversity as a source of secondary metabolites producing natural compounds in Indonesia, for example, the Gewang plant (*Corypha utan Lamk*) that grows in the savanna of East Nusa Tenggara. This plant is commonly used for fish poisoning by indigenous people in East Nusa Tenggara and can be used for cancer treatment. This study used an experimental group with a particular treatment and a control group that external variables cannot fully control.

The research used a non-equivalent control group design with a pretest-posttest control group design technique (Cohen et al., 2000). Respondents were divided into experimental and control groups. The population in the study was 306 students majoring in chemistry, while the research sample was 68 students from two different groups. The sampling technique was purposive sampling type. The researcher randomly chose two groups and gave a pretest question to determine the difference between the experimental and control groups in the initial conditions. The pretest results are considered good if there is no significant difference between the experimental and control groups. The test is ten multiple-choice questions oriented to scientific literacy, including the cognitive level of applying (C3) and analyzing (C4). The questions given refer to the following criteria: (1) the provision of data in the form of graphs and articles on the use of Gewang, (2) an analysis of environmental problems related to the use of Gewang as fish poisoning, (3) interactive questions related to environmental issues and traditional local technology in West Lombok. Scientific literacy questions went through validity and reliability tests before being given to students.

The following research stage is treating the experimental group using learning mulitmedia, made from Adobe Flash based on ethnochemistry using indigenous knowledge material. The conventional learning using the learning media based on Microsoft PowerPoint in the control group. The posttest was given to the experimental group and the control group in the final stage to prove the impact of using multimedia on increasing scientific literacy. The research design is in Table 1.

Table 1. Research Design

Group	Pre-test	Treat-ment	Post-test
Experimental	O1	X	O2
Control	O3	C	O4

(Cohen et al., 2000)

Experimental Group: O1 (Giving a test before using Adobe Flash multimedia based on ethnochemistry using Indigenous knowledge); O2 (Giving a test after the treatment of ethnochemistry-based Adobe Flash multimedia using Indigenous knowledge); and X (Adobe Flash treatment based on ethnochemistry using Indigenous knowledge). Control Group: O3 (Providing a test before conventional learning); O4 (Giving a test after conventional learning); and C (Conventional learning without special treatment).

Quantitative data were obtained after giving scientific literacy tests and questionnaires to determine students' responses to ethnochemistry-based Adobe Flash multimedia using indigenous

knowledge. This study used a scientific literacy instrument consisting of 10 questions that include four indicators of scientific literacy skills, referring to Chiappetta et al. (1991). The instrument was then processed by giving a scale of 0 for the wrong answer and 1 for the correct answer. The multiple-choice content outline of scientific literacy skills is in Table 2.

Table 2. Indicators of Scientific Literacy Questions

Indicators of Scientific Literacy	Sub-indicator of question
Science as a Body of Knowledge	A picture is presented, and students can determine the right concepts and facts related to ethnochemistry.
Science as Ways of Investigation	Various case examples are given, and students can provide reasons for each answer.
Science as Ways of Thinking	A problem is presented, and students can conclude based on valid information.
Interactions between Science, Technology, and Society	Various cases related to using Gewang plants are given, and students can provide appropriate answers to the context of problems related to indigenous knowledge.

The research data were taken twice at the pretest and posttest. The data was processed by calculating N-gain and interpreted in several categories. The results are then analyzed as a unified whole in each indicator. The results of N-Gain were analyzed through categorization based on Hake (1999). The categories obtained generally describe the increased scientific literacy after treatment with ethnochemistry-based Adobe Flash using indigenous knowledge. The scientific literacy ability data is then processed by determining the percentage score of the division between the acquisition score and the maximum score in Table 3, referring to Yusuf (2014).

Table 3. Category of Scientific Literacy Percentage

Interpretation (%)	Category
$81{,}26 < X \leq 100$	Very high
$71{,}26 < X \leq 81{,}25$	High
$62{,}51 < X \leq 71{,}25$	Moderate
$43{,}76 < X \leq 62{,}50$	Low
$0 < X \leq 43{,}75$	Very low

Collection of response data of the use of ethnochemistry-based Adobe Flash multimedia using Indigenous knowledge refers to a Likert scale with four alternative answers. A score of 4 means strongly disagree, a score of 3 means disagree, a score of 2 means agree, and a score of 1 means strongly agree. The scientific literacy instrument was tested for validity and reliability before being applied to research. Based on the validity and reliability test, the validity of all instrument items was decided with a reliability coefficient of 0.833. The Cronbach Alpha value reaches > 0.60, so all items are considered reliable or consistent, and this research instrument is valid (Sujarweni, 2015). The next stage is the normality test of the pretest and posttest scores to determine the normality of the data distribution using the Kolmogorov Smirnov SPSS version 26.0 test.

The data is normally distributed at the value of = 0.05 if it is under the provisions of the Asymp value. Sig (2 tailed) > 0.05. If the value shows that it is normally distributed, then the independence sample t-test is performed so that there is evidence of a significant difference between the results of the pretest and posttest. The next step can be decided based on the value results, Sig. (2-tailed) $p < 0.05$, which indicated a significant difference between the two. When the value of Sig. (2-tailed) obtained $p > 0.05$, then there is no significant difference. The N-Gain test is carried out if the research data is normally distributed.

The effectiveness of using ethnochemistry-based Adobe Flash multimedia using Indigenous knowledge can be seen in the increasing pretest and posttest scores (N-Gain score). Ethnochemistry-based Adobe Flash multimedia using Indigenous knowledge will be declared effective if the N Gain score is 0.3 in the moderate or high category. Table 4 refers to Hake (1999).

Table 4. N-Gain Category

N Gain (%)	Interpretation
$(g) \geq 70$	High
$30 \leq (g) < 70$	Moderate
$(g) < 30$	Low

RESULTS AND DISCUSSION

Experts and lecturers have validated the development of ethnochemistry-based Adobe Flash learning media using indigenous knowledge on secondary metabolite material. Multimedia is an application that can be downloaded via Android or laptop. This multimedia is divided into three sections: introduction, content, and evaluation. The appearance of the introduction section in multimedia is presented in Figure 1.

Figure 1. Introduction of Ethnochemistry-based Adobe Flash Multimedia (Heliawati, 2021)

The specifications for ethnochemistry-based Adobe Flash learning media compared to printed learning media are in Table 5.

Table 5. Specification Comparison of Ethnochemistry-based Adobe Flash Multimedia using Indigenous knowledge

Aspect	Ethnochemistry-based Adobe Flash Multimedia using Indigenous knowledge	Printed Learning Media
Duration	According to individual learning speed	No duration
Efficiency	Multimedia can be published online or offline as an Android application, CD, word processing, web, or Learning Management System	The cost to print a book is expensive
Flexibility	Multimedia can be used for learning without being limited by place and time	Printed media tends to be cumbersome to carry
Feedback	Exercise with direct feedback can provide learning motivation	There is only one-way feedback and no interaction
Ease of Use	Using multimedia on smartphones or laptops is relatively easy and does not require certain smartphone specifications.	Printed media is hard to obtain, especially during online learning.
Audio Visual	The visualization is fascinating and suitable for use by students with visual and auditory learning types	Less able to meet the needs of students with visual and auditory learning types
Scientific Literacy Learning	The learning is constructivism. Students build their knowledge through virtual laboratories and videos.	The available information tends to be factual.
Learning Evaluation	The evaluation results are immediately obtained at the end of the third part (closing).	Students cannot obtain the results directly

The validation of ethnochemistry-based Adobe Flash multimedia using indigenous knowledge by lecturers includes four aspects: software engineering, audio communication, visual communication, and presentation materials. The results of the validation carried out are shown in Figure 2.

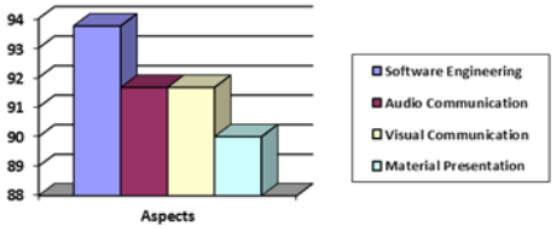

Figure 2. Validation Results of Ethnochemistry-based Multimedia using Indigenous knowledge

In Figure 2, the validity of ethnochemistry-based multimedia using indigenous knowledge from two lecturers as experts has the highest percentage in the software engineering aspect (93.75%), followed by audio communication and visual communication aspects with the same score (91.67%). The lowest aspect (90%) is in the presentation material aspect. The validator generally considers this multimedia appropriate as teaching materials in universities.

Based on the analysis of student responses regarding ethnochemistry-based multimedia using indigenous knowledge, this media is considered to make an essential contribution as an alternative to chemistry learning on secondary metabolites.

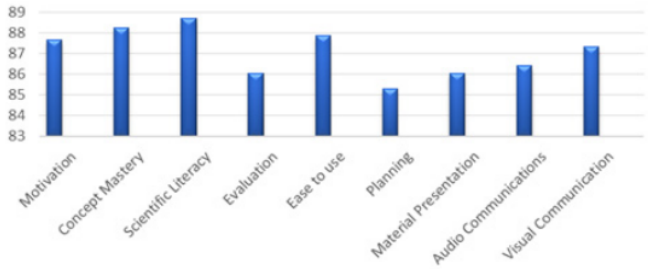

Figure 3. Students' Responses to the Use of Ethnochemistry-based Multimedia

The percentage of students' responses to the use of ethnochemistry-based Adobe Flash learning media using indigenous knowledge in Figure 3 shows an increase in learning motivation (87.68%), with attractively designed teaching media, but still easy to understand so that the evaluation results showed an increase (86.03%). Students can check their level of scientific literacy skills once they have finished working on the questions. Online learning that uses an ethnochemistry approach using indigenous knowledge improves scientific literacy skills (88.69%) and concept mastery of secondary metabolites (88.24%). In the media aspect, students assume that ethnochemistry-based Adobe Flash multimedia using indigenous knowledge is a learning medium with the selection of a suitable virtual laboratory and video (87.32%). Narrative delivery follows the learning theme (86.40%) so that it is easier for students to plan their learning (85.29%) because the characteristics of this multimedia are easy to use (87.87%). From the research on 22 male and 46 female students in the experimental and control groups, there were differences in the results of the pretest and posttest (Table 6).

Table 6. N-Gain Descriptive Statistical Score

	Experimental Group			Control Group		
	Pretest	**Posttest**	**N-Gain**	**Pretest**	**Posttest**	**N-Gain**
Minimum	20	60	-	20	50	-
Maximum	60	100	-	70	100	-
Average	40,29	83,82	0,72	39,71	74,71	0,57

Table 6 shows that the minimum score of students in the experimental group at the pretest was 20, and the posttest was 60. The maximum score at the pretest was 60, and the posttest was 100. This score shows that the average score at the posttest is 83.82, much higher than the average score at the pretest (40.29) and the acquisition of N-Gain scores (0.72 in the high category). The difference in the results was also shown in the control group. The minimum and maximum scores at the pretest were almost identical to those in the experimental group (20 and 70). However, the posttest results showed a minimum score of 50 and a maximum of 100. It was accompanied by an N-Gain score (0 .57 in the medium category). The difference in N-Gain score between the experimental and control groups was then tested for normality by the Kolmogorov-Smirnov test. The experimental and control groups showed the results of the normality test score reaching Sig. 0.200 > 0.05. This result means that the research data is normally distributed. An independent t-test was carried out, as shown in Table 7, to determine the effect of ethnochemistry-based Adobe Flash multimedia using indigenous knowledge, which has significant effectiveness.

Table 7. Results of the Independent T-Test on N-Gain

Levene's Test for Equality of Variances			t-test for Equality of Means		
	F	**Sig**	**t**	**df**	**Sig. (2-tailed)**
Equal variances assumed	0.630	0.430	-2.837	66	0.006
Equal variances assumed			-2.837	64,629	0.006

Table 7 shows that the significance value (Sig) on the Levene Test for Equality of Variances is 0.430 > 0.05, so the variance in the N-Gain data (%) in the experimental group and the control group is homogeneous. Value of Sig. (2-tailed) obtained is 0.006 < 0.05, so there is a significant difference in effectiveness in the treatment with ethnochemistry-based Adobe Flash multimedia using indigenous knowledge against the control group. The results of the analysis of the provision of scientific literacy-oriented multiple-choice questions during the posttest in the control and the experimental groups obtained different percentages for each scientific literacy indicator, referring to Chiappetta and Fillman (2007) as in Figure 4.

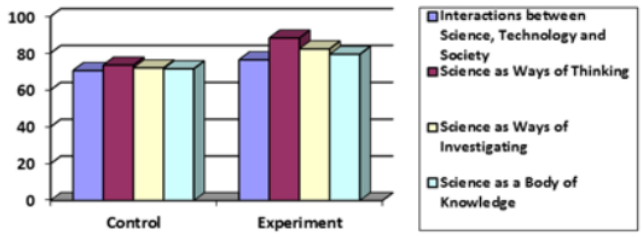

Figure 4. Comparison of Achievement of Scientific Literacy Indicators between Two Groups

The achievement of scientific literacy in Figure 4 shows that the experimental group has a higher average score on all indicators than the control group. On the indicators, Science as Ways of Thinking (88.24%), Science as Ways of Investigating (82.35%), Science as a Body of Knowledge (79.41%), and the lowest indicator is the Interactions between Science, Technology, and Society (76.47%). In the control group, the highest indicator was also obtained in the Science Ways of thinking (73.53%), Science as Ways of Investigating (72.06%), Science as a Body of Knowledge (71.57%), and the lowest indicator is Interactions between Science, Technology, and Society (70.59%).

The most significant increase in scientific literacy skills was achieved on the Science as Ways of the Thinking indicator. This aspect focuses on thinking, concluding, and reflecting on experiments through simulations in virtual laboratories. This interactive simulation has five instructional design principles, including guided

activities (instruction guides), reflection, direct feedback, freedom to explore, and pre-training (Miyamoto et al., 2019). A virtual laboratory has more advantages than a laboratory practicum on secondary metabolite material because it is a learning media that prioritizes user safety (Kapilan et al., 2021) and high efficiency (Faour et al., 2018; Asrizal et al., 2022).

The Science as a Way of Investigating indicator received the second largest percentage. This indicator is where students can solve problems in the form of scientific literacy questions according to the criteria for higher-order thinking skills in pictures or tables. Students in the experimental group are better able to solve problems related to scientific literacy because, in ethnochemistry-based Adobe Flash multimedia, there is a virtual laboratory simulation of secondary metabolites. This finding is reinforced by previous research on virtual laboratory simulations, which are proven to improve students' scientific literacy, especially in the ability to apply scientific concepts in everyday life. (Bortnik et al., 2017; Putri et al., 2021). Students' skills in applying the concept of secondary metabolites using indigenous knowledge will affect their quality of life.

The third-largest percentage is the Science as Body of Knowledge indicator, which includes information, facts, concepts, principles, laws, and theories in ethnochemistry-based Adobe Flash multimedia using indigenous knowledge. Learning materials in the context of indigenous knowledge help students achieve their purposes and more understand real-life scientific principles (Saija et al., 2022). The material is presented in written or video form that the user quickly understands. Another advantage of using video is that it allows users to watch it repeatedly at an unspecified time (Danjou, 2020). Students can better understand the provided material, so there will be no misconceptions (Rubini et al., 2018; Wargadinata et al., 2020). The video about secondary metabolites embedded in this multimedia comes from the Youtube channel, which is proven to present various scientific facts in an informative way (Rosenthal, 2018). After watching the video, students can freely collaborate and express their opinions in scientific discussions (Ndihokubwayo et al., 2020).

The lowest percentage is the indicator of Interaction between Science, Technology, and Society. This indicator relates to applying ethnochemistry to secondary metabolites in the context of indigenous knowledge issues in East Nusa Tenggara. Other research by Nisa et al. (2021) revealed that the same thing was caused by the material regarding ethnochemistry associated with the technology of the people of East Nusa Tenggara, which was not well known by respondents from the local area of West Java. The material about the Gewang plant (*Corypha utan Lamk*), commonly used for fish poisoning by the people in East Nusa Tenggara, has other medical technology benefits such as an anti-cancer or others (Heliawati et al., 2015; Hilaria & Octavia, 2020; Lazarus & Lawa, 2022). It opens students' insight, especially in ethnochemistry, to improve.

CONCLUSION

The students' scientific literacy skills were significantly obtained in the experimental group compared to the control group. The use of various elements in multimedia, such as virtual laboratory, videos, and interactive questions with direct feedback, has been shown to improve scientific literacy skills on secondary metabolite materials using the indigenous knowledge approach of the people of East Nusa Tenggara. Using ethnochemistry-based Adobe Flash multimedia, learning materials that explore the potential of Gewang (*Corypha utan Lamk*) seed extract as an anti-cancer open students' insight into the importance of recognizing the benefits of various biodiversity in Indonesia. This research is expected to encourage discoveries by utilizing natural ingredients native to Indonesia in health and other fields.

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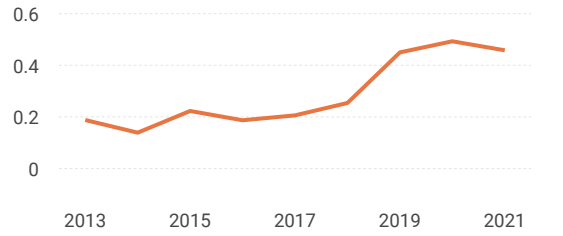

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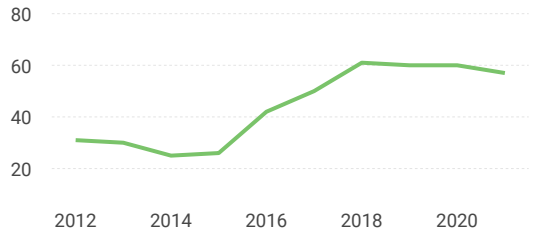

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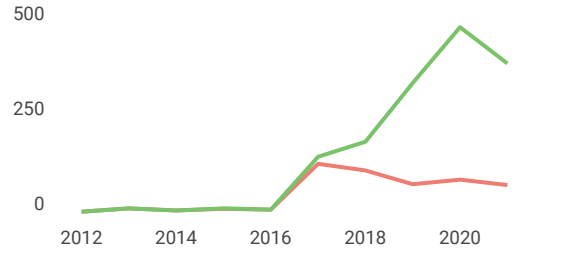

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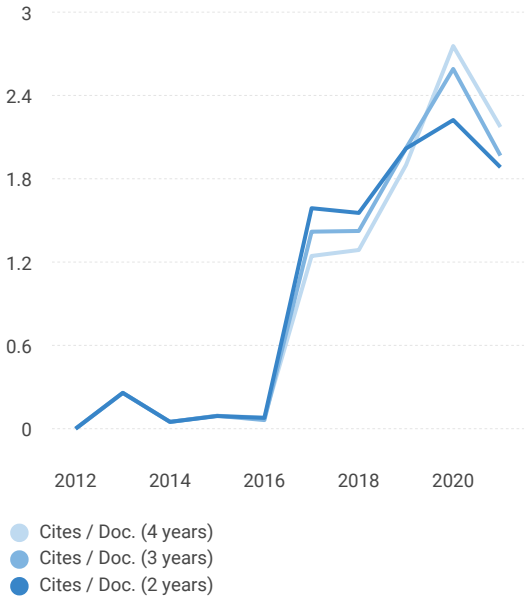

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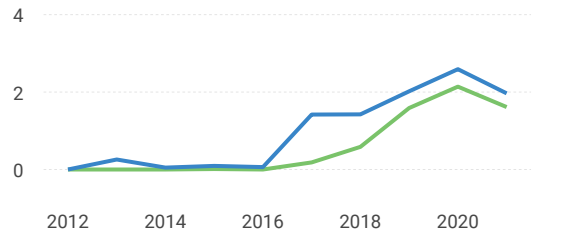

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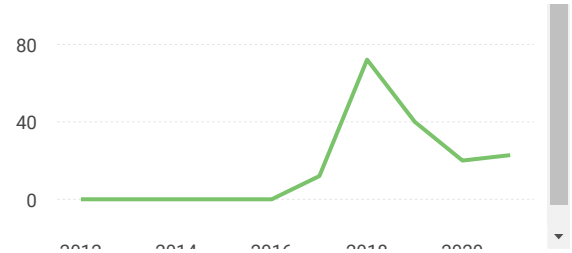

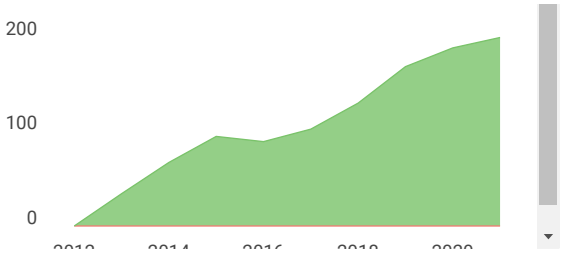

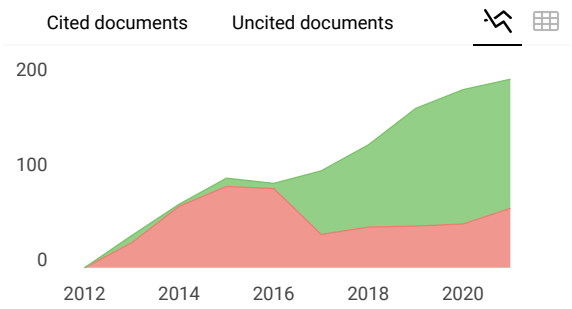

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DEVELOPING SCIENCE CREATIVE THINKING ASSESSMENT LITERACY USING ICARE APPROACH (INTRODUCTION, CONNECTION, APPLICATION, REFLECTION, AND EXTENSION)

Abstract
The teacher competency strengthening program has been carried out by both the central and regional governments, including through education and training (Diklat), but training programs conducted by teacher training institutions have not been successful because most science teachers have not been able to assess high-level thinking skills. The purpose of this study was to design the elementary teacher competency strengthening program through the ICARE approach (Introduction, Connection, Application, Reflection and Extension) to develop science thinking literacy assessment. Research methods used are research and development which are research methods used to produce certain products and test the effectiveness of these products. The subjects in this study were all public elementary schools in Ternate City with characteristics of elementary schools that are located in Downtown, Uptwon and Suburb.
The research was conducted in two stages for 16 sessions with the results obtained by an average increase (gain) of 0.4. The ability of teachers to understand creative thinking assessment literacy is in the medium category in stage 1 and the average increase (gain) is 0.7. The teacher's ability to understand creative thinking assessment literacy is in the high category in stage 2. The teachers have excellent knowledge after attending the teacher's pedagogical competence strengthening training through the ICARE approach. The ICARE approach is very effective for improving students' creative thinking skills.
Keywords: Assessment Literacy, Creative Thinking, ICARE Approach

reply

A **ayu** 4 years ago

saya sangat berapresiasi. terimakasih, selamat berkarya pak/bu, semoga sukses dan terus membanggakan NKRI :) SALAM

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SCImago Team

Elena Corera 4 years ago

Thanks for your participation!

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D **Dr.Kalai Selvan Arumugham** 4 years ago

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