Systematic Literature Review: Analysis of Ethno-STEM and Student's Chemistry Literacy Profile in 21st Century

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Abstract: Chemical literacy is students' understanding of chemical reactions, chemical theories and laws, the nature of chemical particles, and the implementation of chemistry in natural phenomena in everyday life. While Ethno-STEM research is the latest research in Indonesia. This is motivated by the socio-cultural diversity that is owned by Indonesia. The focus of this literature study is to map research topics on chemical literacy and Ethno-STEM that are implemented and analyzed opportunities for implementing chemical literacy and Ethno-STEM in learning. This study used the systematic literature review (SLR) method for the last 5 years (2017-2022). A comprehensive search returns thousands of articles from 4 keywords, namely Ethnoscience, STEM, Ethno-STEM and chemical literacy. After screening, 30 articles were found to be reviewed consisting of 7 STEM articles, 6 ethnoscience articles, 7 Ethno-STEM articles and 10 chemical literacy articles. The findings show that a) Ethno-STEM research in Indonesia is conducted on various topics, the biggest topic its self are about approach and learning models is 32% b) the trend of topics discussing chemical literacy is 62% discussing high school chemistry material; 7% discussed chemistry in college and 7% discussed chemistry topics in junior high school; c) Opportunities for implementing chemical literacy in learning must be fully implemented in learning activities, including the need for textbooks that integrate chemical literacy, standardized evaluation questions, chemical literacy learning videos and other media.

Keywords: Chemical literacy; Etnoscience; Etno-STEM, STEM

Introduction

The 21st century is a century of knowledge competition, global economy, and information technology (Fanani, 2013). The development of science and technology in the 21st century demands an emphasis on the development of superior and quality human resources in order to be able to compete in the globalization era (Primayana, 2019). Education in Indonesia must prepare itself to hone the abilities and skills needed in the 21st century to be able to anticipate the various demands and dynamics of learning developments that will take place in the 21st century (Azalia, 2020). An important skill for students to have in 21st century learning is scientific literacy including chemical literacy (Rahmadani et al., 2018; Shwartz et al., 2006).

Chemical literacy is students' understanding of chemical reactions, chemical theories and laws, the nature of chemical particles, and the implementation of chemistry in natural phenomena in everyday life (Imansari et al., 2018). Ethnoscience learning is a learning strategy which in the process creates an environment and designs experiences by integrating culture into the learning process (Sudarmin & Sumarni, 2018). The application of a learning model with an ethnoscience approach has a significant effect on students' chemical literacy abilities (Imansari et al., 2018; Sanova et al., 2021; Sumarni et al., 2021). The importance of ethnoscience learning in empowering students' knowledge of indigenous knowledge in society needs to be packaged with an integrated and appropriate learning approach to be applied in the 21st century such as the STEM learning model (Parmin, 2017).

STEM learning is learning that integrates knowledge, skills, and concepts so that it can create systematic learning and help students to solve problems well. The application of STEM to learning received positive responses and was able to increase students'

scientific and technological literacy (Rusyati et al., 2019). Research discussing the implementation of STEM learning shows that its application can increase students' chemical literacy (Afgani et al., 2020; Gunawan et al., 2019). Referring to several research results which state that ethnoscience and STEM can improve students' chemical literacy skills, it is believed that chemical literacy will be better if the two are combined in an ethno-STEM form.

Scientific literacy, including chemical literacy, really needs to be taught to students so they can live in the midst of a modern 21st century society. Various efforts have been made in various countries including Indonesia to increase students' scientific and chemical literacy literacy, for example efforts to launch the new 2013 curriculum. However, chemistry teachers as a keystone for the success of these efforts need to understand well the meaning of literacy/chemistry, how to assess and design chemistry lessons that are oriented towards increasing students' chemical literacy. How to assess chemical literacy can use the PISA scientific literacy framework and Shwartz's chemical literacy. Meanwhile, chemistry learning can be designed by optimizing aspects of literacy, namely choosing chemistry topics that have a lot of relevance to students' lives that can be linked to local culture. In addition to preserving local learning, Ethno-STEM-based learning needs to be implemented with a learning model that is in accordance with the 2013 curriculum, namely student-centered learning.

Scientific studies that link chemical literacy, ethnoscience, and STEM are relatively new. Detailed information is scarce and so far no systematic review is available. Therefore, it is necessary to conduct a literature review to reveal the scope of research on chemical literacy and Ethno-STEM from 2017 to 2022 in the 21st century. Thus, the focus of this literature study is to map research topics on chemical literacy and Ethno-STEM that are implemented and analyzed opportunities for implementing chemical literacy and Ethno-STEM in learning. The potential contribution that can be generated from this review study is that it can provide recommendations regarding opportunities for chemical literacy and Ethno-STEM that are appropriate to be implemented in chemistry learning.

Method

This study used the systematic literature review (SLR) method. A systematic literature review (SLR) is a literature review that adheres closely to a set of scientific methods that aims to limit systematic error (bias), primarily by trying to identify, assess and synthesize all relevant studies (of any design) to answer certain questions. or a series of questions (Petticrew et al., 2006). The details of the activities consist of determining data search strategies and/or information sources, selecting studies through quality assessment according to eligibility criteria and quality assessment instruments, synthesis data and data extraction.
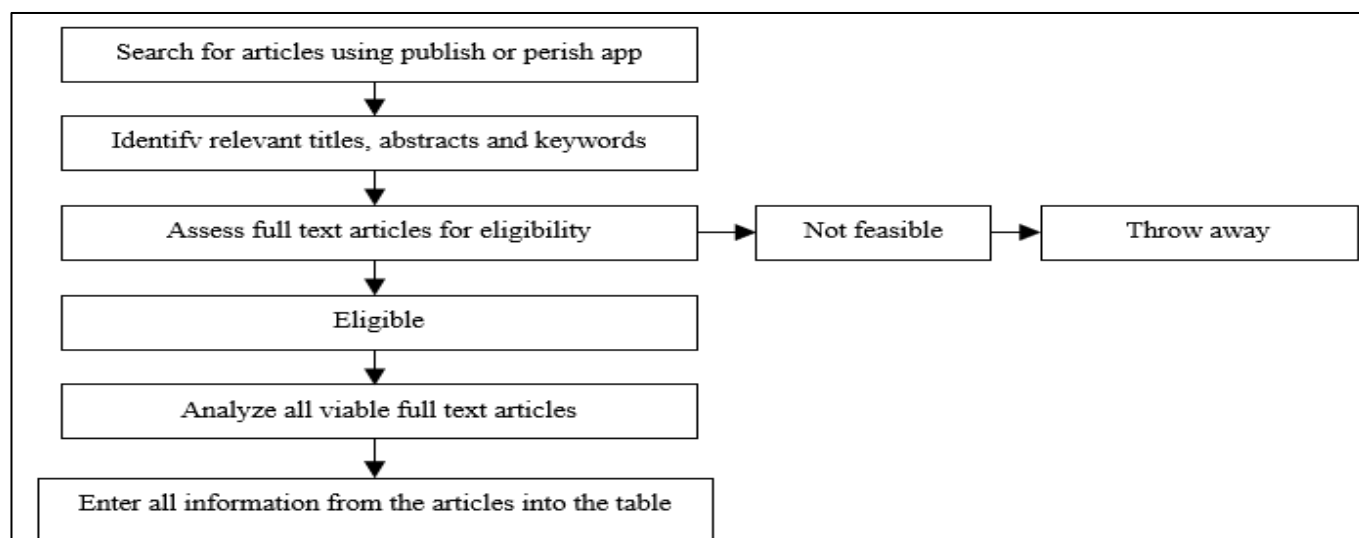

Figure 1. Research method flowchart

The first stage in this research is to find sources of information. The sources of information used in searching for literature come from various databases (Google Scholar, ERIC, DOAJ, website journals) by typing in the keywords Ethnoscience, STEM, Ethno-STEM and chemical literacy. The next stage is the eligibility criteria. The eligibility criteria in this study

used the inclusion criteria. The inclusion criteria for the article search included: (1) articles about Ethno-STEM and chemical literacy in learning; (2) Publication between 2018-2022; (3) publication in an accredited journal; (4) full text and open access. Quality assessment Literature selection uses the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-

analyses) method. PRISMA Flow Diagram in this study is shown in Figure 1.

Based on the PRISMA method that has been done. A comprehensive search returns thousands of articles from 4 keywords, namely Ethnoscience, STEM, Ethno-STEM and chemical literacy. After screening, 30 articles were found to be reviewed consisting of 7 STEM articles, 6 ethnoscience articles, 7 Ethno-STEM articles and 10 chemical literacy articles.

Then proceed with the data synthesis stage. The data synthesis process in this study was carried out by comparing the literature that had met the quality assessment as well as the inclusion and exclusion criteria. The synthesis data refers to the research objectives, namely: a) mapping the research topics of Ethno-STEM and chemical literacy; b) find out opportunities for implementing Ethno-STEM and chemical literacy. The last stage is data extraction. The output of data extraction is in the form of a table consisting of the name of the researcher, year of publication, author's origin, research method, research objective, and research results.

Result and Discussion

Mapping of Implemented Ethno-STEM and Chemical Literacy Research Topics

Based on the results of the review of the article in Table 1, it was found that the interest of researchers with the Ethno-STEM approach was very high. The Ethno-STEM approach supports students more easily in understanding science concepts because the science concepts presented are in the form of integrating local culture that is close to students' lives in the science knowledge taught in schools. Students will feel more enthusiastic about learning and learning will be more meaningful. meaning that the integration of local culture in science learning can be a solution to the problems found in the science learning process (Adnan et al., 2021; Syazali et al., 2022). Learning that is presented with concepts that are close to students' daily lives will make students more active in learning. Student activity will also have an impact on the level of student understanding and student learning outcomes in understanding science concepts.

Table 1. Conducted Article Data

Writer's Name	Year	Method	Purpose	Findings
STEM (7 articles)				
Sarah L., Rachel Friedensen, Tara Marron, Morgan Barlett	2019	Qualitative descriptive	Explored how Latina college students in STEM made meaning of and developed their STEM identities, particularly focusing on the role that religious belief played in shaping STEM identity.	The essence of the experience of having STEM and religious identities for Latina undergraduate students can be defined by three interrelated concepts
Sarah York, Rea Lavi, Yehudit Judy Dori, and MaryKay Orgill	2019	Qualitative Descriptive	To describe some of the potential benefits associated with systems thinking approaches, to identify the STEM education fields that have employed systems thinking approaches, to summarize some of the major findings about the applications of systems thinking in STEM education.	The primary emphasis of peer-reviewed publications was on the development of students', rather than teachers', systems thinking abilities. Existing tools for the assessment of systems thinking in STEM education can be divided into (a) assessment rubrics, (b) closed-ended tools, and (c) coding schemes, with each type of assessment tool having its own unique advantages and disadvantages.
Eric Nersesian, Adam Spryszynski, Michael J. Lee	2019	Quantitative	In this study, we compared MB (monitor-based) and VR educational technologies as alternative supplemental learning environments to traditional classroom instruction using lectures and STEM teaching.	This research project serves as a foundation to determine whether educational technologies have the potential to engage high school students in their STEM classes. This high-level view of technology in the classroom enables us to see if there is viability to continue this stream of research. Even with this level of confounding variables in the classroom, we were able to see changes to students' academic performances.

Writer's Name	Year	Method	Purpose	Findings
Putri Adita Wulandari, I Wayan Dasna, Nazriati	2019	Review Articles	The researcher proposes that research is needed more about STEM learning can improve abilities argue with students in chemistry subjects.	Based on the 5 articles that have been analyzed, it can be seen that learning problem-based learning (PBL) can improve students' argumentation skills. PBL too known to be a learning model that is able to support the STEM approach in learning.
Van Thien Ngo	2021	Mix-Methode	Knowing the effect of STEM (Science, Technology, Engineering, Math) on the learning motivation of first year students.	Application of a learning system with integrated STEM to first year students of lectures.
Nur Candra Eka Setiawan, Sutrisno, Munzil, Danar	2020	The method in this activity is the transfer of knowledge through workshop activities.	The purpose of this activity is to introduce and develop STEM learning designs (Science, Technology, Engineering, and Mathematics) in improving Chemistry Teacher Competence SMA and SMK in Madiun City.	Results of community service activities These are: (1) being able to find solutions to problems faced by chemistry teachers in Madiun City, indicated by the increase in understanding achievement through education and training by 26.36% (seen from the initial test and final test), and (2) teachers'understanding of STEM is 83.81%.
Deni Ainur Rokhim1, Hayuni Retno Widarti, Afis Baghiz Syafruddin	2022	Purpose of this study was to analyze needs in development of teaching materials on topic of corrosion based on STEM-PjBL assisted by instructional videos.	Descriptive research with open and closed questionnaire techniques.	Results showed that teachers and students still used conventional teaching materials that had not been integrated with approaches and methods. In addition, teaching materials have not used information and communication technology.
Etnoscience (7 article)				
Agnes Amila W, Abdurrahman, Agus Suyatna, I Wayan District, Kartini Herlina	2018	Quasi Experimental	Analyze practicality and Effectiveness Ethnoscience-based worksheets are in progress student understanding.	The experimental class using ethnoscience-based worksheets got an increased conceptual understanding.
Danang Triasmoro Adhi, Sudarmin, Suharto Linuwih	2018	Research and Development	Develop instructional video based ethnoscienc.	The instructional video developed is very suitable according to BSNP to increase student knowledge.
Sudarmin, W Sumarni, S Mursiti, and SS Sumarti.	2019	Deskriptive qualitative	Know the character profiles innovative and creative thinking of students in designing batik design chemical after applying the integrated project learning model of ethno-STEM.	The learning model developed can increase students' cognitive knowledge, creativity, innovation, and entrepreneurial character.
FA Adesoji, NA Omilani, and OA Francis	2019	Descriptive	Explore the predictive value of teacher variable; cultural value, experience and gender and; the location of the school under assessment chemistry teacher awareness of ethnoscience practice.	Teachers experience, gender, cultural values and the location of the school has contributed significantly to the awareness composite chemistry teacher on the technique of ethnoscience.
C. A. Dewi, Y. Khery, M. Erna	2019	Descriptive Qualitative	To develop ethnoscience-based chemistry learning to increase scientific literacy.	Development of scientific literacy with curriculum content that pays attention to culture and everyday life to make it happen.

Writer's Name	Year	Method	Purpose	Findings
Eko Risdianto, Meli Junia Dinissjah, Nirwana, Muhammad Kristiawan	2020	Quasi Experimental	Find effects critical thinking skills after learning with an ethnoscience-based learning model direct instruction.	Application of Ethnoscience Learning Model based Direct Instruction influence critical thinking skills and motivation of Students.
CA. Dewi, Martini, Z. Gazali, N. Rahman, M. Zulhariadi, AT. Wicaksono, TP. Astutik	2020	Qualitative descriptive	To develop acid-base modules based on ethnoscience to improve students' scientific literacy skills	Developing acid-base modules filled with ethnoscience to increase students' scientific literacy.
Etno-STEM (6 Articles)				
W. Sumarni and S. Kadarwati	2020 (S1)	A pre-experimental method	Know students' critical and creative thinking skills after applying ethno-STEM pjbl.	Ethno-STEM project-based learning showed a significant effect on the improvement of students' critical and creative thinking skills.
Sudarmin, W Sumarni, S Mursiti, and S S Sumarti	2020 (Scopus)	Qualitative descriptive	To measure the innovative and creative character of Chemistry students in batik motifing of Chemical structures after learning natural products with the integrated STEM approach Ethnoscience.	The profile of innovative and creative character of students after learning with the Etno-STEM approach is very good after.
S. Sudarmin, Woro Sumarni, Rr. Sri Endang P, and Sri Susilogati S	2019 (scopus)	Qualitative descriptive	Designing and implementing the model of project-based learning integrated with Ethno-STEM.	The students responded positively to the developed model of project-based learning integrated with Ethno-STEM.
N Tresnawati, I Saleh, Sudarmin and S Wardani	2020 (scopus)	Research and Development	To implement Biotechnology learning through the Ethno-STEM PJBL model for PGSD students and produce sains batik.	The products of sains batik validatated, one of which is "piperidine seribu daun" has a a secondary metabolite content of the mango combined with the design of thousand of leaves, the special Ciwaringin batik.
S Sudarmin, W Sumarni, S N Azizah, M H H Yusof, and P Listiaji	2019	Qualitative descriptive	To analyze the community's knowledge scientifically of batik process and types of local plants used as natural dyes for batik colouring.	The analysis results revealed that there are numerous plants used in making batik that could produce color substances.
Sudarmin, Woro Sumarni, Dwi Yulianti, Zaenuri	2019	Qualitative descriptive	To develop the entrepreneurial characters of UNNES Chemistry students through the implementation of Natural Product learning integrated with ethno-STEM.	the Natural Product learning integrated with Ethno-STEM was able to well develop the students' mastery concept of chemistry, creative and innovative thinking, perseverance, and conservation of national culture.
Chemistry Literation (10 Articles)				
I Dewa Putu Subamia1, I.G.A.N. Sri Wahyuni, Ni Nyoman Widiasih	2019	Method Education training and assistance.	This activity aims to provide reinforcement and increasing chemical literacy skills.	After being given training there is an increase in knowledge and skills of handling chemicals. Likewise, there has been an increase in the habit of applying safe work practices.
A Y M Sartika1 and E Yusmaita	2020	RnD	To produce a proper and right chemistry literacy assessment toward fundamental law of chemistry and stoichiometry topic based on content validity value and questions numbers, reliability grade.	The result showed that content validity value of the designed chemistry literacy assessment could be categorized as valid. The reliability test is 0.88.
Ade Mutia, Tritiyatma Hadinugrahaningsih, dan Setia Budi	2020	Quasi-experimental with post-test only non-	To determine the positive effects of a guided inquiry learning model with a contextual based approach (CBA) on the chemical literacy of	It can be concluded that there is a positive effect of the guided inquiry learning model with a contextual based approach (CBA) on the

Writer's Name	Year	Method	Purpose	Findings
		equivalents design.	students of class XI MIPA SMAN Jakarta in the hydrolysis of salt.	chemical literacy of students of class XI MIPA SMAN Jakarta in salt hydrolysis.
F. N. Simanjuntak	2020	Articles Review	To propose the synergic collaboration working between academics of chemistry and related sciences in a community service program based on empowerment which is related to health care towards the quality and sustainable Indonesian human resources.	Chemistry literacy within the consumption of NUDIBA food can control the extreme demand on one such of food commodity and lead the community's behavior on biodiversity conservation.
C M Pakesa1 and E Yusmaita	2020	This chemical literacy assessment designed by MER (Model of Educational Reconstruction).	to produce instruments for measure chemical literacy assessment in senior high school with theme the reaction rate.	The analysis shows that 9 of 13 questions in category "valid", 4 questions in category "moderate". Overall analysis results the validity of content designed "valid" with a value of 0.85.
A Wahyuni1 and E Yusmaita	2020	development with MER design	To describe the stages of designing questions using Model of Educational Reconstruction and describing the value of the content validity of chemical literacy questions on acid and base topic.	Based on the results of research, the average value of content validity in the questions was 0.804 with a valid category.
Ni Putu Juni Artini1) dan I Komang Wisnu Budi Wijaya.	2020	Articles Review	Tanalyze the strategy for developing chemical literacy for junior high school students.	The results of the study state that chemical literacy can be developed in thechemistry learning process for junior high school students by implementing contextual learning, facilitating experiments, an integrated approach to three aspects of chemistry and other efforts.
Magfirah Perkasa 1, Nurfina Aznam	2020	RnD	To reveal the developing, the appropriateness and the effectiveness of a chemistry subject specific pedagogy based on sustainability education to enhance chemical literacy and environmental awareness of senior high school students.	(1) the features of chemistry subject specific pedagogy based on sustainability education is using experiential learning was taught to hydrocarbons and the indicators for chemical literacy test and environmental awareness adapted from framework PISA 2015; and (2) the chemistry subject specific pedagogy based on sustainability education is valid to use with very good category and effective.
Pandu Jati Laksono	2018	Qualitative descriptive	To know achievement of chemical literacy skills in the aspects of knowledge, context aspects, competency aspects, and attitude aspects.	Chemical literacy skills of chemistry students in waste management material of 73.33%. These results indicate that students' chemical literacy abilities chemistry education on waste management material is classified as moderate.
Fitri Septi Lutfiani Widodo, Emmawaty Sofya, Tasviri Efkar	2021	Quasi experimental with pretest-postest control group design	To describe the effectiveness of guide inquiry to improving metakognition skills on electrolyte and non electrolyte solutions topic.	Effective guide inquiry and has a high effect size to improve the ability of metakognition on electrolyte and nonelectrolyte solutions topic.

Ethno-STEM research in Indonesia is conducted on various topics. Figure 2 shows that the topic of learning models is 32% (found in articles by Harto et al. (2019), Sudarmin et al. (2019), Sudarmin et al. (2019), Sudarmin et al. (2019), Azalia (2020), Sumarni et al. (2020), Tresnawati et al. (2021)) and an approach of 32% (found in the article Sudarmin et al. (2018), Sudarmin et al. (2019), Izzah et al. (2020a), Qori et al. (2020), Tresnawati et al. (2020), Anugrah (2021)) dominates ethno-STEM research, followed by evaluation and rating of 4% each (found in the article by Izzah et al. (2020b) as shown in Figure 2. The findings are generally in line with trends in Science education research during 2018-2022 published in indexed journals and conferences Scopus, which mainly focuses on the topic of learning contexts (Lin et al., 2019). In addition, current Indonesian ethno-STEM research trends are also in line with international trends which are dominated by goals, policies, curricula, evaluation, and assessment (Li et al., 2020).

The topic of chemical literacy for the last 5 years (2018-2022), namely 62% discussed high school chemistry material including: basic laws of chemistry and stoichiometry, hydrolysis of salts, electrolytes and non-electrolytes, buffer solutions, reaction rates, acid-base and redox, 7% discussed chemistry in college (waste management), 7% discussed chemistry topics in junior high school.
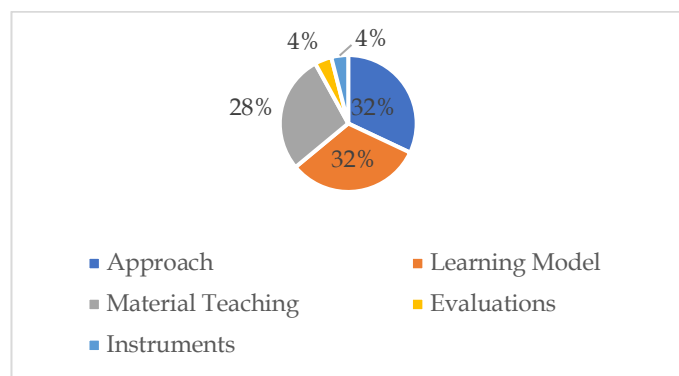

Figure 2. Percentage distribution of ethno-STEM topics in science learning

Most research trends discuss the effect of learning models on chemical literacy abilities. Some of the suggested models include: Guided Inquiry, React, inquiry (Hadinugrahaningsih et al., 2019; Mutia et al., 2020; Zahara et al., 2019). This indicates that improving chemical literacy skills must be supported by learning that fosters students' creativity and activeness, one of which is the Ethno-STEM approach. Other research on chemical literacy is in the form of development research, namely in the form of developing chemical literacy test instruments and learning tools (Artini et al., 2020; Perkasa et al., 2016; Sartika et al., 2020), and research on community service/training is still small. This training

or workshop activity can be a potential for the development of chemical literacy activities in the future.

Opportunities for the Implementation of Ethno-STEM and Chemical Literacy in Learning

Based on data on trends in the implementation of Ethno-STEM research in science learning, several topics have not been fully explored. The researchers' recommendations regarding these findings are as follows: (1) the need for quantitative research to be able to determine the effectiveness of ethno-stem in learning science; (2) the development of ICT-based learning media in Ethno-STEM learning needs to be done to deal with rapid technological developments; (3) development of teaching materials with broader local knowledge such as local culture in each region; (4) Integrating ethno-STEM approaches with 21st century learning models to help students improve students' abilities in the 21st century, for example, chemical literacy skills.

Important chemical literacy instilled in chemistry learning. This is because every individual is always faced with chemical phenomena and problems (Subamia et al., 2019). Chemical literacy is one of the individual benchmarks in understanding chemistry. The development of chemical literacy can be done in various ways, including: carrying out learning that is complemented by experimental activities, carrying out active and fun contextual learning (Artini et al., 2020).

Research data shows that the chemical literacy category of students is mostly in the middle position (Laksono, 1970; Saija, 2019). This provides an opportunity for the implementation of chemical literacy in learning to be fully implemented in learning activities, including the need for integrated chemical literacy textbooks, standardized evaluation questions, chemical literacy learning videos and other media. On the other hand, the teacher's readiness to apply chemical literacy is an important point, because the teacher is at the forefront of transferring knowledge and understanding to students.

Conclusion

Based on the results and discussion, it can be concluded that: a) Ethno-STEM research in Indonesia is conducted on various topics, the biggest topic its self are about approach and learning models is 32% b) the trend of topics discussing chemical literacy is 62% discussing high school chemistry material; 7% discussed chemistry in college and 7% discussed chemistry topics in junior high school; c) Opportunities for implementing chemical literacy in learning must be fully implemented in learning activities, including the need for textbooks that

integrate chemical literacy, standardized evaluation questions, chemical literacy learning videos and other media.

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