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Validity and effectiveness of chemical practicum e-modules of various applications with ethnoscience approach in chemical learning: Analysis review

Jacky Anggara Nenohai[1,*], Sri Rahayu[2] and I Wayan Dasna[2]

[1]Chemistry Education Study Program, Postgraduate, State University of Malang, Malang 65145, Indonesia
[2]Department of Chemistry, University of Malang, Malang 65145, Indonesia
*Corresponding author: JAN, jackynenohai82@gmail.com

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ABSTRACT

This study intends to determine (1) the relevance of the practicum e module to the curriculum in chemistry learning; (2) the validity of the chemistry practicum e-module from various applications; and (3) the effectiveness of the application of the Ethnoscience-integrated chemistry practicum e-module in chemistry learning. This study uses the Systematic Literature Review (SLR) method using online article databases, namely ERIC and Google Scholar, which are limited to the last 5 years. The articles reviewed were 15 articles according to the topic. The results of the review show that the practicum e-module is in line with the curriculum in chemistry learning. Not to mention, practicum guides that go hand in hand with the times are very essential to be developed so that students can adapt well and learning becomes efficient with the current developing era. So, it is important to develop an electronic integrated practicum guide that creates balance between hard skills and soft skills in the curriculum concept. The validity of the chemistry practicum e-module from various applications in the implementation of online and offline practicum can be accepted by teachers and students, so that the teaching and learning process in proving theories in terms of practicum can be prepared. Especially in the future pandemic crisis, it is necessary to develop students' scientific literacy in terms of content, competence, context, and attitudes that are focused on preparing the next generation of scientific literacy through a culture-based curriculum to produce more contextual learning.

1. Introduction

The development of technology and information in this era of globalization is very significant and affects many aspects, one of which is in the field of education. Education plays an important role for a nation, because if the quality of education in a nation increases, the human resources will also increase, as well as the quality of the nation's generation. Realizing the importance of the education sector, every country is competing to improve the quality of education in order to compete in the global world (Hemayanti et al. 2020). Along with the times, students are not only influenced by technology but also by culture. The fact is that today's students are more familiar with foreign cultures and do not understand the culture and local wisdom of the Indonesian people, so that

students' sense of nationalism begins to fade. In order for the existence of culture and local wisdom to remain strong, students as the nation's next generation need to be taught to love culture and local wisdom by integrating cultural knowledge in the learning process (Nuralita, 2020). One of the efforts to introduce local culture to the young generation is through education by developing an ethnoscience integrated learning model. The use of local culture in learning stimulates students to make direct observations and students are trained to be able to find out for themselves various concepts that are studied thoroughly (holistically), meaningfully, authentically, and actively (Damayanti et al. 2017). Therefore, it is necessary to develop cognitive, affective and psychomotor abilities of students related to culture. In realizing the success of education, the government provides one of the guidelines for organizing teaching and learning activities to achieve the educational goals, namely the curriculum. The current curriculum is the 2013 curriculum. One that leads to learner-centered learning and places more emphasis on achieving 3 aspects, namely attitudes, knowledge and skills, all of which are summarized in hard skills and soft skills competencies so as to motivate students to further develop creativity according to experience and improve learning outcomes (Siahaan et al. 2021).

The implementation of the curriculum will be realized if there are parties who act as facilitators and directly interact with students, namely teachers. The teachers' task is to create teaching and learning activities that are fun, innovative, effective and efficient. In addition, teachers must be able to develop teaching materials, media and practicum modules that can help students achieve predetermined learning goals and make students learn to the fullest. Currently, we still have to deal with the COVID-19 pandemic, so the Minister of Education and Culture of the Republic of Indonesia issued a decree to organize the teaching and learning process from face-to-face (offline) to learning from home with an online system (online) for all levels from school to university to prevent the spread of COVID-19 in the education sector (Novira et al. 2021). Therefore, online learning requires teachers to compile or design teaching materials as attractive as possible, selecting appropriate strategies, approaches, methods and learning models, as well as interactive media so as to re-engage the interest and motivation of students to learn optimally despite being uneasy in a short period of time. Especially in chemistry subjects related to practicum which requires the accuracy and skills of students in reacting a substance with other substances (Nisa et al. 2022).

Practicum is an activity for students to gain understanding and closure related to the concepts taught in class and obtain data and information directly through the scientific process in practicum activities, especially on abstract chemistry material. Most of the chemistry materials are material that has abstraction, so that in learning it requires student activities that can make them understand these materials. In addition to learning activities in the classroom, there are activities in the laboratory. In addition to the cognitive domain, what needs to be considered is the psychomotor skills of the students. Therefore, chemistry learning in schools must be accompanied by activities in the laboratory as a means of developing students' psychomotor skills (Pakpahan et al. 2021; Silaen & Silaban, 2022; Mawaddah & Silaban, 2022).

Practicum activities in chemistry learning are generally at the high school level including the type of confirmation inquiry level practicum, in which students do practicum based on problems, procedures, analytical techniques and interpretations that have been prepared by the teacher in the form of practicum modules (Manalu et al. 2016). Laboratory activities play a huge role, especially in creating conceptual understanding, verifying (proving) the correctness of concepts, growing process skills (basic skills in scientific work and students' affective abilities), and fostering a sense of love for science lessons (Lubantoabaing, 2019). Chemistry practicum activities at the high school level are also only carried out for some chemistry materials and mostly carried out during practical exams for twelfth-grade level, so that students are not very proficient in doing chemistry practicums. This will affect the skills of students, especially the twelfth-grade students, who will continue their education

levels to ones related to practical work in the laboratory (Giammatteo & Obaya, 2018). Moreover, during the current pandemic, students cannot carry out chemistry practicums so that students lack the competence to conduct experiments using chemicals and equipment in the laboratory directly (Rahman et al. 2020).

To overcome this problem, a learning media assisted by application-based software is needed that can support the implementation of online chemistry practicum. There are many various applications that can be used in the development of chemistry practicum e-modules to become a supporting medium in learning chemistry. The use of this e-module will help students to be motivated, and improve students' higher order thinking skills and student learning outcomes. In addition to applications that can support the development of practicum e-modules. An approach that improves student literacy in the use of practicum e-modules is also needed, one of which is the ethnoscience approach or local wisdom (Setyorini et al. 2022). The ethnoscience function will make it easier for students to explore facts and phenomena that exist in society and be integrated with scientific knowledge (Dewi, 2019). Ethnoscience can attract students to learn because it is related to their own local identity. In addition, the application of chemistry concepts in social life is directly related to local wisdom. Local wisdom is a motivational stimulus for students to construct their knowledge. The integration of cultural competencies in different professions will be the key determinant of professional services, including in the field of education (Dewi, 2019).

Based on the advantages of ethnoscience learning and the development of practicum e-modules in conducting practicums, especially the current Covid-19 pandemic situation, the researchers wanted to analyze the validity and effectiveness of chemistry practicum e-modules from various applications with an ethnoscience approach in chemistry learning to inform that development and the application of the practicum e-module can be a solution in carrying out the practicum. Therefore, the research objectives are: How is the relevance of the practicum e-module to the curriculum in chemistry learning?; How is the validity of the chemistry practicum e-module from various applications?; and How is the effectiveness of the application of the ethnoscience-integrated chemistry practicum e-module in chemistry learning?.

2. Method

This research uses a systematic literature review (SLR) method. SLR is a literature review that follows a standard set of rules to identify and synthesize all relevant studies and provide an assessment of what is known about topic of the study (Xiao & Watson, 2019). With the application of the SLR method, more informative summaries or research syntheses and comprehensive research criticisms can be obtained. SLR in this study was carried out by searching for the results of scientific research publications using online article databases, namely ERIC and Google Scholar. The advantages of Eric and Google Scholar over the others are can access Abstracts of more than 1 million journal articles, research reports, books, teaching guides, and other types of educational literature. ERIC can also provide you with copies of many of the documents abstracted in the database, and Google scholar can also provide guarantee quality to the performance measurement of scientific citation achievement Indonesian higher education academics (Darmalaksana, 2020). The keywords used are curriculum relevance with chemistry practicum modules, practices e-modules chemistry development, android based practicum module development, and ethnoscience approach in chemistry. This keyword can be created by ourselves or look for a word or phrase that makes it possible to describe an information. For example we will look for information about the development of android-based practicum modules, keywords that can be used are; module development, practicum module, android, android-based module. In addition, it can also be added with related

keywords such as chemistry, interactive media, applications. The flow of the article search and screening process can be seen in the flowchart in Figure 1.

Based on the search results of both online article databases, 2599 articles were found. The articles were re-sorted based on the criteria so that inclusion obtained 268 articles. Then sorted based on the needs of researchers according to the chosen topic. The final total of articles that will be used are 15 articles according to the topic of chemistry, namely 5 articles from the ERIC database and 10 articles from Google Scholar. Inclusion criteria for article searches carried out include: (1) Publication is limited to the last 5 years (2017 until 2021); (2) articles from reputable journals indexed by Eric and Google Scholar, and (3) full text and open access to articles conference papers and the result of research.

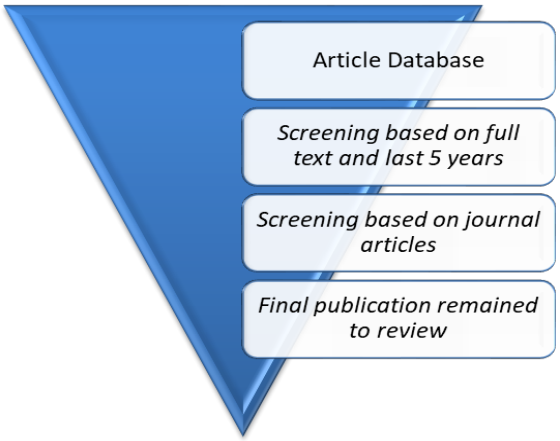

Figure 1. Article screening flowchart.

In analyzing this data, namely by applying a qualitative approach in systematic review that is used to synthesize (summarize) research results that are qualitatively descriptive and quantitative. Sequentially, this systematic review research process aims to synthesize all qualitative and quantitative research results to explore the development of practicum e-modules in accordance with the android-based 2013 curriculum with an ethnoscience approach. Literature sources are all qualitative publications related to the development of android-based practicum e-modules through systematic search methods. The synthesis process includes themes and concepts from the relevant studies extracted, the results of this extraction are arranged into important (main) findings, the findings are grouped into categories, the categories are then synthesized into themes (adapted to the conceptual framework arranged) so as to produce coding according to keywords in reviewing practicum e-modules.

3. Results and Discussion

In the review analysis, there are 3 articles related to the relevance of the practicum e-module to the curriculum, then there are 8 articles related to the validity of the chemistry practicum e-module and 5 articles related to the effectiveness of the ethnoscience-integrated chemistry practicum e-module application.

3.1. The Relevance of Practicum E-Modules to Curriculum in Chemistry Learning

The curriculum that applies as a guide for organizing teaching and learning activities to achieve the current educational goals is the 2013 curriculum. The 2013 curriculum can create productive, creative, innovative, affective Indonesian people through strengthening attitudes, skills and knowledge that are integrated and have 4 major changes, namely: (1) the concept of a balanced

curriculum between hard skills and soft skills starting from Graduate Competency Standards, Content Standards, Process Standards, and Assessment Standards (2) The use of student books is more emphasized on the activity base, not reading material (3) Each book contains learning models and (4) projects that will be carried out by students and an assessment process that supports student creativity (Lubantoabaing, 2019). Based on this, the fourth Core Competence in the 2013 curriculum is a skill competency which requires students to be proficient in both theory and practice. With practical activities, of course, it can make students' mastery of material better, because chemistry is obtained and developed based on practicums that answer the questions of what, why and how. For this reason, evidence is obtained from the theories that have been put forward by chemists (Rahmawati, 2018). In addition, in laboratory activities students have the opportunity to find and perform everyday phenomena in their lives (Lubantoabaing, 2019). In addition, based on the results of Lucila's research (2018), the assessment of Chemistry Laboratory Skills through a Competency-Based Approach in High School Chemistry Courses shows that by having a consistent evaluation plan and providing effective feedback to students, the level of competence of students in laboratory practice can be significantly improved. Based on this, practicum guides that go hand in hand with the times are very important to be developed so that students can adapt well and learn to be efficient in the current developing era. So, it is important to develop an electronic integrated practicum guide (accessible online). This is an answer to the demands of the times that are currently entering the digitalization era and are adapted to students' learning styles (Harefa & Purba, 2019).

3.2. Validity of the Chemistry Practicum E-Module from Various Applications

The development of laboratory-based learning (practicum) is very important in accommodating the era of the industrial revolution 4.0. The development includes supporting facilities and infrastructure for the laboratory and most importantly from the side of the teacher who becomes the facilitator. One thing that needs to be considered is the availability of practicum guides that accommodate the era of the industrial revolution 4.0. The practicum guide has a crucial role in the meaningfulness, success, and efficiency of the practicum process (Harefa & Purba, 2019). Based on a survey from Harefa & Purba (2019), stating that 93.70% of students think that e-module is more practical, 86.61% think it is easy to use, and 95.28% think that the content is more interesting. The use of e-module in the practicum process is considered very efficient and effective by students as users. Students think that the use of e-modules is more practical, easy to use, and has more interesting content than conventional practicum modules.

Based on this, there are many results of developing chemistry practicum e-modules that use software that attracts students' motivation and helps the practicum process. The results of the validation of the chemistry practicum e-module from these various applications can be seen in Table 1.

Table 1. Validation Results of Chemistry Practicum E-Modules from Various Applications.

No	Application Name	Validity Results	Chemistry topic	Sources
1	*Kvisoft Flipbook Maker*	Fulfilling the valid criteria by the material validator based on the aspect of content substance assessment with a percentage of 88.89% and learning design that is 97.22% and by media validators based on display (visual communication) with a percentage of 96.88% and software utilization which is 100%. Meanwhile, the responses of users based on the responses of teachers and students were in	Thermochemistry	(Saraswati & Linda, 2019)

		very good criteria with scores of 92.61% and 86.80%, respectively.		
		The media legality validator score percentage was 91.70% for the ion balance and pH of the edition buffer solution; and 94.18% for the solubility equilibrium edition, while according to the material validator was 93.75% and 94.45%, respectively. The level of response scores of users through questionnaires for teachers and students in the ionic equilibrium edition and the pH buffer solution edition were 87.08% and 88.45%, respectively; while the solubility equilibrium editions obtained 94.25% and 91.43%, respectively.	Chemical Equilibrium	(Linda et al. 2018)
2	MOOC Chemistry e-content module	The e-content module has high content validity (CVI = 1.00) and a good reliability index (α = 0.94). The mean scores for students' perceptions of module content (M = 3.66, SD = 0.55), usability (M = 3.43, SD = 0.56), design (M = 3.41, SD = 0 .59) and the effectiveness (M = 3.47, SD = 0.56) of the construction was high. This MOOC Chemistry e-content module is expected to be a good online resource in the teaching and learning process of Chemistry in universities.	Basic Chemistry	(Hamid et al. 2021)
3	*Android-Based Animation*	The results of this study are an android-based chemical element testing learning application which is expected to be implemented in chemistry lessons. Especially for high school students, as an interesting alternative learning media to make it easier for chemistry comprehension.	Chemical Elements	(Saputra et al. 2021)
4	Canva	The validation results show that the average validation value is 91.48% for display, content, grammar, and evaluation system items. Cronbach's alpha test showed an average alpha value of 0.903. The results of the response questionnaires show that the average response score is greater than 8.00 for each questionnaire item, while the average score for the application of the e-module laboratory course is 8.88. This indicates that the basic chemistry practicum e-module is quite well used as teaching material in the online learning process.	Basic Chemistry	(Puspita et al. 2021)

Based on several applications in the development of the practicum e-module, it shows that the overall validity of the e-module is very good and can be used as a learning resource during the pandemic. In the future, this electronic-based module can be used for online and offline practicums and can help educators prepare teaching materials in dealing with future pandemic crises.

3.3. Effectiveness of the Ethnoscience-Integrated Chemistry Practicum E-Module Application in Chemistry Learning

The effectiveness of the chemistry practicum e-module especially using the ethnoscience approach is very helpful in learning chemistry and increasing student literacy (Utari et al. 2021). Ethnoscience approach which is original knowledge in the form of language, customs and culture, morals, and technology created by certain people or those who hold on to implicit knowledge (Azalia et al. 2020). The importance of ethnoscience learning in empowering students' knowledge that has been embedded in them to develop original knowledge in society with integrated learning, namely the use of Science, Technology, Engineering and Mathematics (STEM) learning models modified with an ethnoscience approach (Azalia et al. 2020). Azalia's research results (2020) that the application of an ethnoscience-integrated STEM e-book affects students' learning outcomes and generic science skills on chemical equilibrium material. Sumarni's research (2018) results that the application of ethnoscience-based learning in chemistry can improve students' chemistry literacy, especially at intermediate to high level in all groups of students (Sumarni, 2018). Ethnoscience pedagogy in chemistry learning can develop students' scientific literacy in terms of content, competence, context, and attitudes. The development of scientific literacy needs to be done by focusing on preparing the next generation of scientific literacy through a culture-based curriculum to produce more contextual learning, especially learning resources used in the classroom learning process to promote local culture related to basic chemistry learning. This type of learning resource will facilitate students' conceptual understanding as it relates to the culture of society and everyday life.

4. Conclusion

The results of the review show that the practicum e-module is in accordance with the 2013 Curriculum which can produce productive, creative, innovative, affective students through strengthening attitudes, skills and knowledge in chemistry learning. Not to mention, practicum guides that go hand in hand with the times are very essential to be developed so that students can adapt well and learning becomes efficient with the current developing era. So, it is important to develop an electronic integrated practicum guide that creates balance between hard skills and soft skills in the curriculum concept. The validity of the chemistry practicum e-module from various applications in the implementation of online and offline practicum can be accepted by teachers and students, so that the teaching and learning process in proving theories in terms of practicum can be prepared. Especially in the future pandemic crisis, it is necessary to develop students' scientific literacy in terms of content, competence, context, and attitudes that are focused on preparing the next generation of scientific literacy through a culture-based curriculum to produce more contextual learning.

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