



Culturally Wetland Responsive Teaching to Improve Science Literacy and Wasaka Character

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Abstract: Chemistry students still have low levels of scientific literacy, although in the era of the Industrial Revolution 4.0 and the transition to Society 5.0, students need these skills. An alternative for raising students' scientific literacy and character is the Culturally Wetland Responsive Teaching (CWRT) approach. This developmental research tested the validity, practicality, and effectiveness of e-modules based on CWRT for the colligative properties of solutions. The ADDIE development model was used for the research method. Both test and non-test instruments were used for data collection. The e-module was tested on 23 students from grades A1 and A2 in the Chemistry Education Study Program at a public university in South Kalimantan, Indonesia. The analysis showed that the e-modules were highly valid regarding content, presentation, language, and media feasibility. They were also highly practical in individual and small group tests, limited trials, and assessing lecturers' ability to use e-modules and manage classes. The modules were effective, as evidenced by the N-gain value of science literacy competence and the *wasaka* character of students in the high category. The results suggest that e-modules based on Culturally Wetland Responsive Teaching are valid, practical, and effective for teaching the colligative properties of solutions.

Keywords: culturally wetland responsive teaching, science literacy, *wasaka* character

Recommended citation: Syahmani, Iriani, R., Kusasi, M., Prasetyo, Y.D., Norhasanah, H., & Rahman, N.F.A. (2024). Culturally Wetland Responsive Teaching to Improve Science Literacy and *Wasaka* Character. *Journal of Innovation in Educational and Cultural Research*, 5(2), 196-206.

INTRODUCTION

One of the most considerable contributions to human life has been the swift advancement of science and technology. High global competitiveness and enhancing human resource quality via education are necessary. To support the learning process and raise educational standards by fostering scientific literacy competencies, the educational system must help students reach their full potential and acquire soft skills (Widayoko et al., 2019; Mentari et al., 2018). The Organization for Economic Cooperation and Development (OECD) initiated the measurement of science literacy competencies through the Program for International Student Assessment (PISA). The results of the PISA measurement in 2018 showed that the science iteration in Indonesia is ranked 70 out of 78 countries with an average score of 396, which indicates that the quality of education in Indonesia is still far behind the quality of education in Indonesia is still far behind compared to other countries (Kahler et al., 2020). This is reinforced by research showing that students' science literacy competence is still low. As future educators, students must have science literacy competencies to help students when they become teachers (Shaffer et al., 2019; Laksono, 2018).

A preliminary study was carried out using the results of a needs analysis of several chemistry education students who have taken School Chemistry 1. Students feel that the use of lecture books so far does not feel that the use of lecture books so far has not been effective, and the chemistry learning that has been done has also not practised science literacy skills; learning has also not trained science literacy skills. They only get information from lecturers and have not implemented it in the classroom and everyday life. In addition, teaching is still centred on the lecturer, so students rarely do activities related to character related to character. As a result, most of them lack responsibility and are lazy when doing the tasks given by the lecturer. Students also still need complete guidance in learning because they are not used to building their knowledge to play an active role in learning. Moreover, learning chemistry requires high interpretation and reasoning power (Talanquer, 2022). Chemistry also has very complex chemical concepts and many complicated chemical formulas (Rusek et al., 2022). The low understanding of chemistry concepts is influenced by character education. Character education is essential in learning; we are familiarized with behaviour coaching and can improve academic achievement optimally (Abidin, 2018; Hartutik et al., 2017; Haryani et al., 2017). Success in completing their developmental tasks can also be separated from how individuals take responsibility in their lives by applying

values in society and life in society. Internalization of character values in learning to provide a meaningful learning experience (Nashihin, 2019). The meaningfulness of learning is a significant factor in improving students' science literacy and *wasaka* character. Still, in reality, connecting knowledge in everyday life with the theory learned in class is difficult. Learning will be more meaningful if adjustments are made to the conditions and potential of schools and student characteristics; one is by integrating culture and the environment as part of the learning process (Kusumah et al., 2020; Ramsay-Jordan, 2020).

Using a constructivism-based approach, educators can introduce these attributes to their students. The Culturally Responsive Teaching (CRT) approach allows teachers to integrate chemistry material with the surrounding community's culture through various meaningful activities (Rahmawati et al., 2020). Creating engaging teaching materials that are relevant to students' everyday experiences and cultural backgrounds to apply a constructivism-based learning approach and foster meaningful learning (Iyamuremye et al., 2023; Tanase, 2022; Sutrisno et al., 2020; Polman et al., 2020; Suwignyo & Saryono, 2019). The material developed relates to the colligative properties of solutions. This content was chosen because it relates to environmental and cultural factors in solving more complex problems that are relevant to the computer-supported collaborative learning (CSCL) model (Syahmani et al., 2020) with CRT approach to fostering complex problem solving (Han et al., 2014; Glazewski & Ertmer, 2020). The collaborative learning models with CRT approach assisted by computer technology (Cheng et al., 2021; Leonard, 2021; Hoffman et al., 2022; Novak & Khan, 2022) or online course/video (Cortes, 2023; Schirmer & Lockman, 2022) support to students in solving problems and learning together effectively to improve the achievement of learning outcomes include *wasaka* character, and scientific literacy (Alameddine, 2021; Selles, 2020; Namdar & Shen, 2017).

The CSCL model for enhancing science literacy skills will be aligned with the development of e-modules based on Culturally Wetland Responsive Teaching (CWRT) to improve science literacy skills in conjunction with the character of Waja Sampai Kaputing or *Wasaka*. Education in chemistry can help to develop this trait, which is typical of the people of South Kalimantan. It should be incorporated into the educational process to familiarize students with this distinctively regional character. The educational process should incorporate the *wasaka* character to familiarize students with the distinct nature of their area. Numerous studies have examined the use of e-modules in the learning process using a cultural approach. Still, only a few have connected it to the context of wetlands, science literacy, and *wasaka* character. This research aims to analyze the efficacy, validity, and practicality of e-modules based on CWRT in fostering science literacy and *wasaka* character development, focusing on colligative properties based on the description given.

METHODS

This research and development study follows the ADDIE model's five stages of analysis, design, development, implementation, and evaluation (Branch, 2009; Rothwell & Kazanas, 2013). The ADDIE model research flow is presented in Figure 1 below.

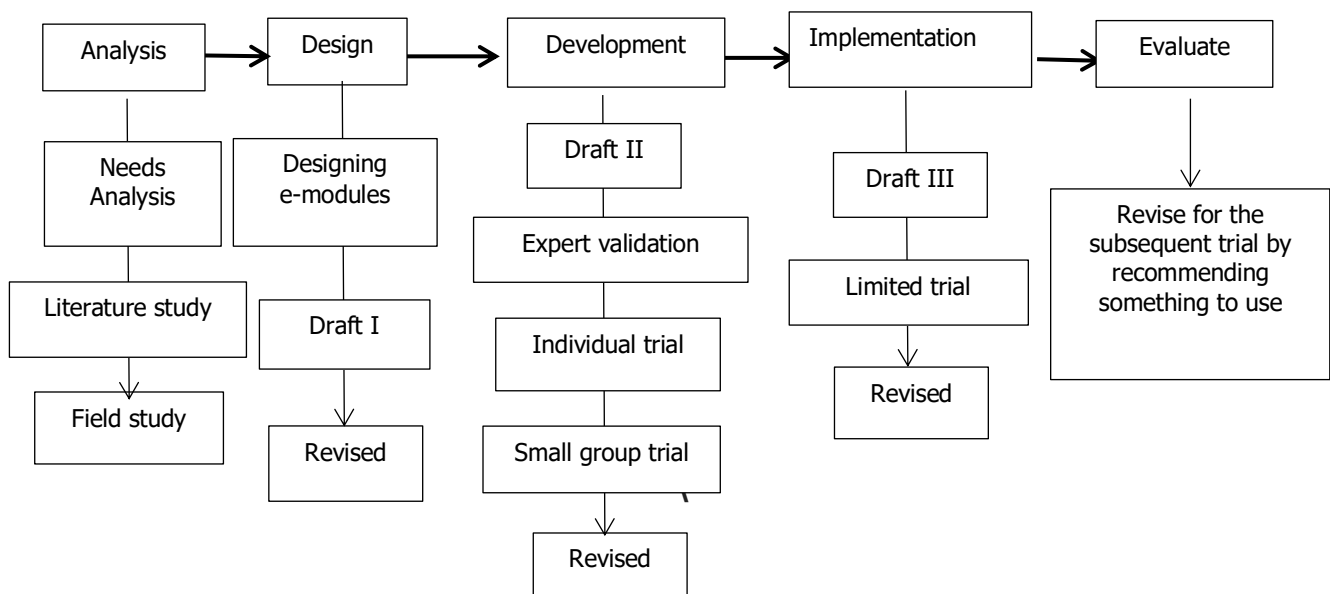


Figure 1. ADDIE model development design

The subjects in this study were 25 students of Chemistry Education. The sample in the individual trial used 3 students, a small group trial of 5 students, and a limited trial of 15 students. Before the trial, the validation stage was carried out first by 5 experts consisting of 4 Chemistry Education lecturers and 1 lecturer in Educational Technology at a public university in South Kalimantan, Indonesia. The instruments used in this study were to measure science literacy and *wasaka* character. The science literacy test consisted of 10 essay questions adjusted to the science literacy indicators, and the *wasaka* character assessment was measured based on observation sheets by 3 observers, which included aspects of hard work, resilience, and responsibility. Each aspect is divided into 4 indicators. Data collection employed various methods, including observation, questionnaires, tests, and non-tests. The preliminary study involved the utilization of the observation method. Expert opinions, lecturer assessments, individual trial feedback, small group trial feedback, and limited trial student responses were gathered through questionnaires. Pre-test and post-test assessments were conducted to measure students' science literacy levels before and after using the e-modules. On the other hand, non-testing data were collected through character analysis via observational observations to assess the validity of the e-modules, test instruments, questionnaires, and observation sheets. The validation and practicality score uses a Likert scale of 1-5 (Table 1). Validity categories and instrument trials with the following criteria. Practicality analysis is measured through the results of readability questionnaires, student response questionnaires, and the implementation of e-modules based on CWRT.

Table 1. Validity and Practicality criteria

Validity criteria		Practicality criteria	
Score	Category	Score	Category
$4.20 < V \leq 5.00$	Very valid	$4.20 < P \leq 5.00$	Very good
$3.40 < V \leq 4.20$	Valid	$3.40 < P \leq 4.20$	Good
$2.60 < V \leq 3.40$	Quite valid	$2.60 < P \leq 3.40$	Moderate
$1.80 < V \leq 2.60$	Less valid	$1.80 < P \leq 2.60$	Low
$1.00 < V \leq 1.80$	Invalid	$1.00 < P \leq 1.80$	Very low

(Syahmani et al., 2022)

Effectiveness analysis was measured through test and non-test instruments. The test instrument was used to measure students' science literacy, consisting of 10 essay questions; the questions were adjusted to the indicators to be achieved. The results of the student science literacy assessment were then reviewed through the n-gain score to see the effectiveness of the test. The results of calculating students' science literacy n-gain score are then converted into the n-gain score classification with the criteria in Table 2.

Table 2. Criteria for students' science literacy n-gain scores

Value n-gain score $\langle g \rangle$	Classification
$\langle g \rangle \geq 0.70$	High
$0.30 \leq \langle g \rangle < 0.70$	Medium
$\langle g \rangle < 0.30$	Low

(Hake, 1998; Syahmani et al., 2020)

The analysis of the achievement of the *wasaka* character can be determined from the average score of the observation results by 3 observers of each student on the character observation sheet. The average score results are compared with Table 3.

Table 3. *Wasaka* character achievement criteria

Score average	Skills level
$X > 3.4$	Very good
$2.8 \leq X \leq 3.4$	Good
$2.2 \leq X \leq 2.8$	Enough
$1.6 \leq X \leq 2.2$	Not enough
$X \leq 1.6$	Very less

(Adaptation Wati et al., 2021)

RESULT AND DISCUSSION

The research that has been done uses development research with the ADDIE model, which includes 5 stages: 1) Analysis, 2) Design, 3) Development, 4) Implementation, and 5) Evaluation. The following are the research results obtained based on the previously described method. The analysis stage aims to identify

problems in the learning context (Winarti et al., 2022). The analysis techniques used are observation, questionnaires, and relevant research analysis techniques. The following is a description of the analysis conducted and the findings obtained.

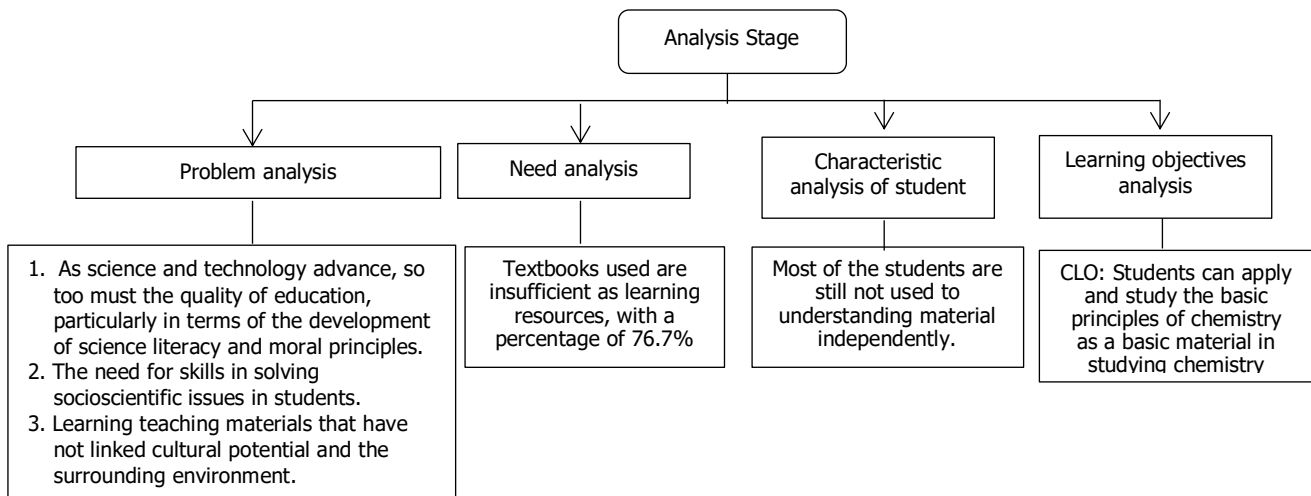


Figure 2. Findings of the analysis stage

The product developed is the e-module Colligative Properties of Solutions using the CWRT approach. The parts of the developed e-module are organized and designed to provoke students to practice the thinking process. Students need to experience changes in preconceptions to gain a more scientific understanding. Problem-based learning is one of the right strategies for constructing prior knowledge (Barke et al., 2009; Choden, 2020; Winarti et al., 2022). The following is the visualization of the e-module Colligative Properties of Solutions using the CWRT approach.

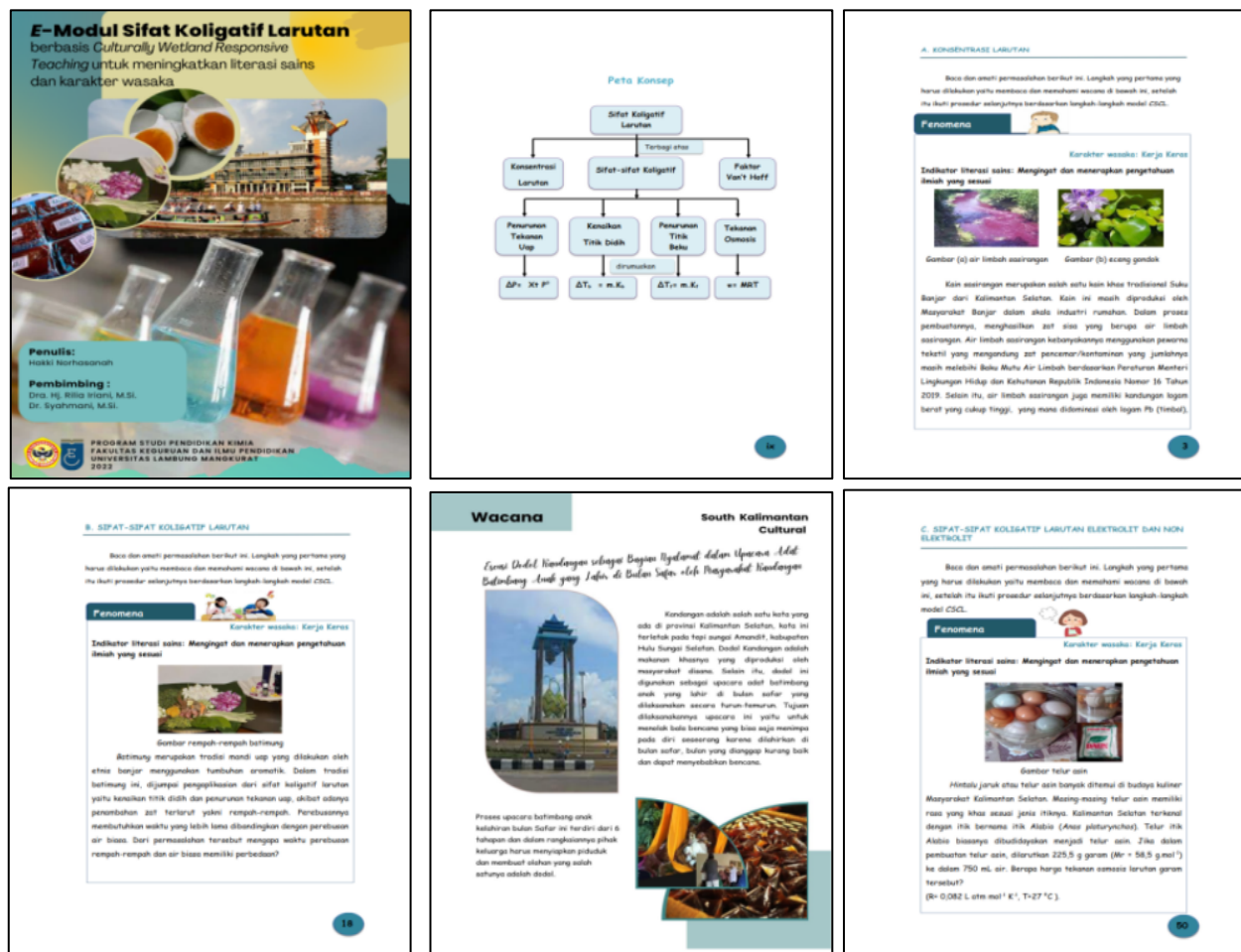


Figure 3. Visualization of e-module based on CWRT

The development stage aims to determine whether the e-module developed is suitable for use. At this stage, 5 validators carried out the validity test to produce draft 1 of the e-module based on Culturally Wetland Responsive Teaching and then continued the revision stage once. Four aspects of feasibility were assessed, namely content, presentation, language, and media feasibility. The results of the evaluation of the feasibility aspects of the e-module based on CWRT are briefly presented in [Table 4](#).

Table 4. Results of the assessment of the component aspects and e-module content test items

Assessment Aspects	Validators					Validation Score	Description
	I	II	III	IV	V		
Content	4.38	4.92	4.46	4,23	4.92	4.58	Very valid
Presentation	4.93	4.93	4.93	4,27	5.00	4.81	Very valid
Language	4.57	5.00	4.50	4,21	5.00	4.65	Very valid
Media	4.87	5.00	4.75	4,25	4.87	4.75	Very valid
Average						4.69	Very valid

Table 5 shows that the average validation score is 4.69. The average validation score meets the category of very valid, so it is suitable for use. The content aspect assessment received a validation score (4.58); this acquisition is inseparable from several aspects, including (1) The material presented is by the applicable CLO, (2) It has innovative and creative properties for students, (3) E-modules also utilize technology as a form of integrating the CSCL model in learning and presenting various information and real contexts to facilitate students in learning activities. In their research, [Sari et al. \(2023\)](#) state that local potential contributes significantly to the learning process. The existence of local potential integrated with e-modules can help students understand the concepts taught. The assessment on the presentation aspect received a validation score of 4.81. Some validators argue that the presentation of concepts in the e-module based on CWRT is systematic; the supporting part of the presentation is equipped with pictures, and there are introductory, content, and closing sections. This is in line with research conducted by [Adawiyah et al. \(2022\)](#) that the validity of an e-module based on CWRT in the presentation aspect is declared very valid because of the integration of the presentation so that learning becomes more meaningful.

The language feasibility aspect gets a validation score of 4.65. This shows that using language in an e-module based on CWRT is good and correct. The language portion of the e-module obtained a score of 0.79 with a valid category, indicating that the module complies with Indonesian language guidelines and uses simple language to make the material offered easily understood by readers ([Adawiyah et al., 2022](#)). The media feasibility aspect received a validation score of 4.75. This is based on research conducted by [Maryono et al. \(2021\)](#), who found that the assessment of e-modules based on the CWRT approach is very valid. The display of the e-module based on CWRT before and after revision in [Table 5](#).

Table 5. E-module based on CWRT before and after revision

Before Revision	After Revision
Selecting a better color scheme and correcting non-contrasting page numbers	Ensuring the color scheme is suitable and contrasting
Rechecking the summative test, especially in the answer choice section, and adding variables that are not yet in the question	Rechecking the questions and adding variables
The use of terms in the glossary section that use mixed language (Indonesian and English)	Improve the words and definitions of the glossary.

The e-module based on CWRT was continued with the readability test in individual trials and small group trials. Based on the above calculation, the average student readability score on the individual trial is 4.53, which is a very good category. However, minor revisions are still needed according to suggestions and input from students, namely, including learning videos in each sub-chapter. As for the average readability score on the small group trial, which was 4.54, included in the very good category, students commented positively about the e-module at this stage. The results of calculating the student response score to the e-module amounted to 4.38, which is included in the very good category. This shows that the e-module based on CWRT that has been developed is suitable for use in the process of teaching and learning activities. As determined by the calculations mentioned earlier, the average student readability score in the initial assessment is 4.53, placing it within the "very good" category. However, minor revisions are still required based on feedback and suggestions from students, particularly regarding the inclusion of educational videos within each sub-chapter. As for the average readability score in the subsequent small group evaluation, it stands at 4.54, also falling within the "very good" range. At this stage, students have provided positive feedback about the e-module, indicating that the e-module

based on CWRT that has been developed is well-suited for integration into the teaching and learning process.

This stage conducted a limited trial to determine the effectiveness of the e-module based on CWRT. The effectiveness of the e-module was measured through data from the pre-test and post-test results of science literacy competencies and observation sheets of students' *wasaka* characters. The science literacy competency test is 10 essay questions tailored to science literacy indicators and related to the material developed. The results of students' achievement of science literacy indicators were analyzed from the assessment of exercise questions before being given the e-module (pre-test) and after being given the e-module based on CWRT (post-test) in the limited trial. Based on each aspect of science literacy, the n-gain value obtained is high. The highest n-gain value is obtained in interpreting data and evidence scientifically, with a value of 0.78 and a high level of achievement. In contrast, the lowest N-gain value is obtained in describing scientific phenomena with a value of 0.66 in the medium category. In summary, the n-gain value of scientific literacy per aspect can be seen in Table 6.

Table 6. Science literacy n-gain values per aspect

Aspects of Science Literacy	Question Items	Pre-test	Post-test	N-gain	Description
Describe phenomena scientifically	2,3,4,5,9	37,78	79,11	0.66	Medium
Designing and evaluating scientific investigations	7,8	33,33	83,33	0.75	High
Interpret data and evidence scientifically	1,6,10	24,44	83,70	0.78	High
Average N-gain		31.85	82.05	0.73	High

The results of the *wasaka* character assessment were assessed by observers before and after using the e-module based on CWRT for two meetings. The *wasaka* characters trained are aspects of hard work, toughness, and responsibility. A description of the n-gain value of students' *wasaka* character per aspect can be seen in Table 7 below.

Table 7. The n-gain value of student *wasaka* characters per aspect

<i>Wasaka's</i> character aspect	Pre-test	Post-test	N-gain	Description
Work hard	2.51	3,42	0.61	Medium
Toughness	2.71	3.60	0.69	Medium
Responsibility	2.84	3.87	0.88	High
Average			0.72	High

The first indicator observed was hard work, with an n-gain of 0.61 in the medium category. It's challenging to develop the *wasaka* character trait of hard work. This results from the students' lack of experience with active learning before implementing the e-module based on CWRT. This statement is reinforced by Hutchison and McAlister-Shields (2020) also Isa and Bunyamin (2022), which show bridging culture and science education in implementing CRT. Students can participate in social interactions that are real and pertinent to them in an ideal learning environment (Kaukko et al., 2022). In addition to learning about other cultures, educators must be able to recognize the customs and values specific to their own culture and modify their pedagogical approaches to emphasize diversity in the classroom (Pagan, 2022). The second indicator observed is toughness. The assessment points are that students are trained to never give up when working on the assigned tasks, always trying to find answers seriously. Developing a tough character is important because it will form an unyielding attitude to achieve the expected goals with an n-gain of 0.69 in the medium category. In line with this, Benawa et al. (2020) state that personal toughness is relevant in the disruption era. Mental toughness is a psychological construct that helps people perform competently and confidently (Ruparel, 2020). Additionally, the ability to persevere in completing tasks, maintain composure in various circumstances, overcome hardship, maintain confidence, and consistently perform well in a dynamically changing environment are all examples of mental toughness (Suharti & Kurniawawti, 2023).

The third indicator observed was responsibility, with an n-gain of 0.88 in the high category. This is because in carrying out tasks, students are trained to make decisions and solve problems in groups until the task is completed (Annisa et al., 2022). Problem-solving efforts require consideration of various aspects to find a solution or middle ground. The process of identifying problems and using problem-solving skills when making decisions in both social and academic problems is a responsible decision-making attitude (Virginanti et al., 2019). These results show that students have completed decision-making responsibly through their answers when working on the question sheets and assignments given. The research data shows that the observation of the *wasaka* character of students after using the e-module based on CWRT is a high category with an average n-gain of 0.72. Amini et al. (2017) state that for character education to be achieved, students must instill this character education in themselves to develop these characters. Due to the choice of learning methodologies

and models that can assist in training *wasaka* characters, it is claimed that an e-module based on CWRT can train *wasaka* characters in students. In addition, it can also be seen through the results of filling out student response questionnaires, observation sheets of lecturers' ability to use e-modules, and observation sheets of lecturers' ability to manage classes. Each has a practicality score of 4.38, 4.47, and 4.54, respectively. The results of the practicality score mean that the e-module based on CWRT is very practical to use. In line with the research of [Widiantari et al. \(2022\)](#), a product developed is said to be practical if it can be applied in the field and the level of implementation is included in the good category. [Table 8](#) presents the evaluation stage of the developed product. This stage provides feedback to product users so that revisions are made according to the evaluation results ([Maydiantoro, 2021](#)). The evaluation stage is carried out at all stages to minimize the occurrence of errors and produce a good e-module based on CWRT.

Table 8. Results of the evaluation stage

Evaluate	Evaluation Results	Improvement/Follow-up
Analysis stage	Not analyzing the learning style of each student	Should do learning style analysis
Design stage	The presentation of the material is still not in-depth	Expand the more relevant material
Development stage	Make revisions according to the validator's suggestions	Refine suggestions from validators
Implementation stage	Only carried out until the limited trial and did not record when the research took place	Expected more comprehensive testing (field trials) and can do the recording process.

The novelty of e-modules based on CWRT compared to other e-modules is that they are innovative and creative for students in understanding lecture material. E-modules also utilize technology to integrate into the learning process, reflecting culturally responsive, communicative teaching and learning activities ([Berlian & Huda, 2022](#)). Context-based chemistry learning can direct the thinking process and motivate students, resulting in the development of science literacy competencies ([Wiyarsi et al., 2020](#)). Applying an e-module based on CWRT in the learning process that integrates science and culture can improve students' understanding of science concepts ([Sari et al., 2023](#)). Learning will be more effective if they utilize the environment or equipment around them to stimulate their curiosity to make observations and trigger questions so that they can conclude and gain experience through the scientific process ([Wina et al., 2017](#)). The function of local culture makes it easy to explore facts and phenomena or problems that exist in society and are integrated with scientific knowledge ([Dewi et al., 2019](#)). [Rahmawati et al. \(2019\)](#) suggested that leveraging a location's cultural features or environment as a learning resource to improve learning, make connections between learning and daily life, and develop strong connections with their students ([Lloyd et al., 2015](#); [Chitpin & Karoui, 2021](#)). Being involved in making discoveries and applying the material to real-world concepts helps students learn chemistry more effectively and retain it better ([Winarti et al., 2022](#); [Polman et al., 2020](#)). Future research will carry out multidisciplinary/multicultural CRT-based STEM/Ethno-STEM projects to make learning more meaningful in developing scientific literacy and character ([Davis & Allen, 2020](#); [Suh et al., 2022](#); [Syahmani et al., 2023](#)).

CONCLUSION

The e-module colligative properties of solutions based on CWRT developed are valid, practical, and effective. The e-module is effective in improving science literacy and *wasaka* character, as evidenced by the n-gain scores of 0.73 and 0.72 in the high category, respectively. These results show that CWRT-based e-modules can be an appropriate learning resource in introducing science through the cultural context of the region; through this process, students can feel the presence of chemistry in real life and produce a more meaningful learning process. The diversity of cultural backgrounds, family backgrounds, upbringing, language, ethnicity, gender, and achievement levels can help us understand the difficulties and problems. Cultural involvement teaches students to respect and empathize with other students and embeds *wasaka* characteristics such as working hard, responsibility, and toughness.

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