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Development of Problem-Based Learning Integrated Sasambo Ethnochemistry in Colloid-Based Chemistry Teaching Materials

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Abstract: This research aims to determine the feasibility of product development for colloid-based chemistry teaching materials and problem-based learning integrated with Sasambo ethnochemistry to increase students' chemical literacy. This research is part of a development research procedure that adopts the 4-D model, with stages to define, design, develop, and disseminate. Test the suitability of teaching materials using a questionnaire to test content validity and construct validity. And reliability. The content and construct validity analysis technique uses the V index, while the reliability of teaching materials uses the kappa moment coefficient (K). The content and construct validity analysis results showed that the criteria were very valid, with a V index of 91.36% and 90.7%. The reliability analysis results of teaching materials obtained a kappa moment coefficient (K) of 0.88 with a very high reliability category. Based on the validity and reliability values, it is concluded that colloid-based chemistry teaching materials and problem-based learning Sasambo's integrated ethnochemistry are very suitable for learning.

Keywords: Ethnochemistry Textbook; Feasibility Analysis; Validity of Teaching Materials.

Introduction

Education is a planned effort to realize an active learning process to develop personality, intelligence, and skills needed for oneself and society [1]. Higher education must provide students with insight, skills, and experience for their lives, so there needs to be a match between the material taught and daily expertise [2]. The ability to use scientific concepts to apply them in everyday life, explain scientific phenomena, and describe life phenomena based on scientific evidence is part of the skills literacy needs today [3].

Ethnochemistry is the study of chemistry from the perspective of local wisdom that contributes to matter and its changes. [4] One of the characteristics of integrated ethnochemical chemistry learning is that it incorporates elements of local culture into the chemistry learning process as a learning medium [5]. The ethnochemical approach is one of the contextual approaches that links the material taught with students' real situations, in this case, local cultural content, which is presented as a learning medium that can encourage students to connect the knowledge they have and its application in everyday life [6].

According to Baker, D., & Taylor, the learning process by integrating community culture will be easier for students to understand. [7] Learning chemical literacy by teaching chemical concepts integrated with local culture can begin with observations from real-world contexts by linking to molecular and symbolic representations of chemical phenomena [8,9].

A lack of supporting reading materials causes the low level of chemical literacy among students, an inability to connect chemical concepts [10], and the choice of learning strategies or models [11]. According to Gherardini, scientific literacy skills can be improved through learning that activates students [12].

This reality is a challenge for the Chemistry Education Study Program as an institution providing prospective chemistry teachers to develop learning tools that support conceptual understanding, chemical literacy, and problem-solving abilities. For this reason, it is necessary to innovate teaching materials into PBL-based teaching materials that integrate chemical concepts reflected in local communities' cultural traditions.

Sasambo ethnochemistry is a cultural behaviour of the Sasak, Samawa, and Mbojo ethnic groups related to chemical concepts. Colloid Chemistry studies dispersion systems, their properties, and how to make them. There are many examples of colloids in everyday life because of the local culture of the Sasambo people, such as *cendol daluman*, *cerorot*, *surabi*, *pencok* and other traditional snacks that can be integrated into the preparation of teaching materials.

Teaching materials are learning tools arranged systematically and provide information about competencies and learning objectives. [13] The development of teaching materials needs to consider the accuracy of the material, suitability of content and context, suitability of the material to the curriculum, accuracy of illustrations, pictures, symbols, and experiments, as well as the suitability of the material presented to the students' abilities [14].

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To ensure that the resulting teaching material product is suitable for use, it is necessary to test the validity and reliability of the product. The validity of teaching materials is related to the extent to which the teaching materials can achieve learning objectives [15]. At the same time, reliability shows the extent to which the results of a measurement can be trusted [16]. Interpretation of validity is based on the content of the material (*content)*, criteria (*criterion-related validity*), and concept (*construct*). ([17] Content validity is a type of validity that measures the content components that should be present in a teaching material. [18] Criterion validity is a feasibility test that compares test scores with reference criteria. In contrast, construct validity reflects the construction of teaching materials in terms of structure frameworks, languages, and so on [19].

Teaching material is valid when it meets general and specific criteria. [20] Criteria General contains principles, steps, and presentation of teaching materials. Meanwhile, special criteria include scientific criteria, educational and teaching science, and criteria for the readability of teaching materials. [21] This explains that teaching material is valid if it is by the material presented, motivates students to read, and arouses students' curiosity to explore the material being studied further. Teaching materials are said to be valid if they include two elements, namely, the title and supporting information. [15] The title of the teaching material contains matters related to identity, while the supporting information relates to the author's willingness and skills in presenting the material. Several components in teaching materials are title, table of contents, instructions, instructions for use, introduction, materials, exercises, and bibliography [22].

Based on the description above, the formulation of this research problem is how appropriate the teaching materials are regarding content validity, construct and reliability of colloid-based chemistry teaching materials. *Problem-based learning,* which integrates *sasambo* ethnochemistry to increase chemical literacy in students

Research methods

The PBL-based teaching materials developed in this research contain six stages of PBL that adopt Mutiah's PBL syntax: orientation to the problem, literature study, finding solutions, designing experiments, presentations, and experiments—integration [23], which is integrated with Sasambo ethnochemistry.

The development approach used refers to the 4-D approach, which was developed with stages: definition (*define*), planning (*design*), development (*develop*), and spread (*disseminate*) [24]. Validation and reliability of teaching material products is part of the development stage to describe the feasibility of teaching material products.

Data collection techniques use questionnaires to measure content validity, construct validity, and reliability. Four experienced panelists carried out validity and reliability tests. Content validity includes four aspects of assessment, namely the accuracy of scientific content, suitability of teaching materials with PBL syntax, suitability of teaching materials with literacy indicators, and integration of Sasambo ethnochemistry in scientific content. Construct validity includes four aspects: the content component, linguistic component, presentation component, and graphic component. The reliability of teaching materials is measured based on the level of agreement (*agreement)* from the raters to state the consistency of the measurements. The content and construct validity analysis technique uses the formula:

$$V = \frac{\text{Total empirical score}}{\text{Total expected score}} \, x100\% \text{ [25]}$$

Analysis of the level of validity of teaching materials using the validity criteria for teaching materials, as in Table 1 [15].

Table 1. Validity criteria for teaching materials

No	Number	Validity Category
1	85.1%-100 %	Very valid
2	70.1 %- 85 %	Fairly valid
3	50.1%- 70 %	Not valid
4	0.1% - 50 %	Invalid

Using teaching material reliability analysis techniques Inter-Reter Reliability (IRR) by calculating the coefficients Cohen Kappa (K). with the following formula [3].

Moment kappa (K) = $(\rho_0 - \rho_e) / 1 - \rho_e$

Information:
K = Kappa moment
ρ_0 = The number of scores given by panellists divided by the maximum score
ρ_e = The maximum score is reduced by the number of scores the panellists gave divided by the maximum score.

Results and Discussion

Integration Analysis of Sasambo Ethnochemistry in Colloid Chemistry

The Basic Chemistry RPS analysis results showed that colloid chemistry includes colloid systems, colloid properties and colloid production. Identification of the relationship between local Sasambo culture and the concept of colloid chemistry is carried out by analyzing local culture or cultural results that are relevant to the idea of colloid chemistry by examining raw materials, production results, or the sequence of events of community activities in the Sasak, Samawa, and Mbojo tribes. The results of identifying the local Sasambo culture, which will be integrated into colloid chemistry, are shown in Table 2.

Table 2. Integration of Sasambo Ethnochemistry in Colloid Chemistry

Colloid Chemistry Concept	Integration of Natural Phenomena / Local Culture Sasambo
Colloid System: colloid type,	Cendol daluman, vegetable ares, cerorot, satay pencok, wild horse milk, mina sarua, satay

dispersing phase, dispersed phase in colloids	bulayak, tofu, shrimp paste, poteng, smoke from burning post-harvest rice fields, clouds of Mount Rinjani hat, clay for making thief jug pottery and pearls from shellfish farming pearl
Colloidal properties: Tyndall effect, Brownian motion, adsorption, coagulation, lyophilic colloids, and lyophobic colloids	The color of Mount Rinjani's clouds, fog, smoke from burning rice fields after harvest which reduces visibility, light entering the gaps in the roof of a traditional Sasak house, coagulation of soy milk by traditional salt drops in making tofu, making dangke from wild horse milk, and heating coconut milk in making jeleng oil.
Colloid preparation: Dispersion method	The ngelamur process is the process of mixing finely ground dry clay with water to produce sol colloidal clay for making burglar jug pottery, making pottery coloring paint from the juice of burnt tamarind seeds, and grinding it.
Condensation Method	Making tofu colloid (gel) from soy milk colloid (emulsion) by pressing to reduce the water solvent, making agar agar from seaweed, making cendol daluman

Based on table 2 shows that all the concepts of colloid chemistry can be integrated into the local culture of the Sasambo people. The study of local cultural products is presented through pictures or videos equipped with a storyline of the manufacturing process so that the content of the teaching materials is expected to attract students' attention.

The integrated colloidal chemistry material on sasambo ethnochemistry is designed to be student-centered by displaying the stages of PBL syntax. The problem orientation stage was intended to display problems in the culture of the Sasambo community. Likewise, identifying problems, finding solutions, designing experiments, presentations, and experiments by integrating Sasambo ethnochemistry. Each stage is designed to build chemical literacy by recognizing problems in local communities, explaining daily situations, explaining scientific phenomena by recognising scientific evidence, designing and testing scientific ideas, participating in scientific discussions, and providing assessments of scientific issues in local communities.

Content Validity

Test the content validity of colloid-based chemistry teaching material products *problem-based learning*. Sasambo's integrated ethnochemistry to increase chemical literacy consists of 4 assessment aspects: the accuracy or correctness of scientific content, PBL syntax, chemical literacy indicators, and Sasambo petrochemical integration. The results of the recapitulation of the validity values of the teaching material content are shown in Table 2 below.

Table 3. Content validity value of teaching materials for each indicator's

Aspect	V	Validity criteria
The truth of scientific content		Very valid
PBL syntax	96.25 %	Very valid
Ethnochemical integration	91.67 %	Very valid
Chemical Literacy	87.50 %	Very valid
Rate rate	91.36 %	Very valid

Based on Table 3 above, it can be seen that the average content validity value is 91.36% with very valid criteria. This shows that the content of the teaching materials developed is suitable for lecturers and students in the learning process to achieve learning objectives through the PBL learning model.

Regarding correctness, the scientific content of colloid chemistry in teaching materials obtained a V index of 90.0% with a very valid category. This explains that the content of the material presented in the developed teaching materials is by theory, law, and application with a wide range of material, following developments in knowledge and technology that enable students to obtain information from various sources.

The suitability of PBL syntax in teaching materials received a score of 96.25% in the very valid category. In the development of teaching materials, PBL syntax has been displayed as a sequence of sub-chapter activities, starting from problem orientation, lecture material, finding solutions, designing experiments and presentations, to testing conclusions with a simple experiment, as shown in the table of contents in Figure 1.


BAB 1 SISTEM KOLOID 1
1.1 Capaian Pembelajaran 1
1.2 Orientasi Masalah 1
1.3 Identifikasi Masalah 2
1.4 Materi Perkuliahan 3
1.5 Pencarian Solusi Permasalahan 6
1.6 Merancang Percobaan 10
1.7 Presentasi Rancangan Percobaan 10
1.8 Data Hasil Percobaan 11
1.9 Kesimpulan 11
1.10 Tes LIterasi Kimia 12
1.11 Rubrik Penilaian 13
1.12 Daftar Pustaka 14

Figure 1. Display of PBL Syntax Sequence

The material displayed in each syntax is an activity that students must carry out to be active as a group. This shows that teaching materials are designed to be student-centred so that lecturers can measure cognitive, affective, and psychomotor aspects.

The integration aspect of Sasambo ethnochemistry in teaching materials received a V index value of 91.67% with a very valid category. This means that 91.67% of the problems presented in the teaching materials have integrated the local culture of the Sasak, Samawa, and Mbojo tribes. The integration of Sasambo ethnochemistry in teaching materials is shown in Figure 2 below.

Tabel 3.Daftar makanan/minuman khas Suku Sasambo NTB

No	Makanan / Minuman	Deskripsi
1	sumber: Tribrata News	**Sayur Ares** adalah masakan khas suku sasak lombok yang terbuat dari santan, kedebong pisang muda,dan campuran daging, Masakan ini biasanya ditemukan di acara begibung yaitu acara makan bersama yang diadakan setelah acara pernikahan yang biasanya dihadiri keluarga dan kerabat. Tuan rumah akan menyajikan satu loyang bundar besar yang berisi nasi dan lauk termasuk sayur ares, lalu itu akan dimakan bersama dengan 2-5 orang pada satu loyang bundar besar. Rasa sayur ares ini sangat unik yaitu manis dan gurih. Menurut penduduk suku sasak, sayur ares ini ditemukan oleh Loq Ares, beliau menemukan makanan ini di kala musim kering panjang yang melanda pulau lombok pada masa lampau sehingga menyebabkan banyak hewan ternak mati kelaparan. Namun di antara hewan ternak yang mati tersebut ada sapi yang masih bertahan dengan makan kedebong pisang muda. Loq Ares mencoba mengambil kedebong pisang itu dan memotongnya kecil-kecil lalu di masaknya dengan bumbu yang ada di dapur. Karena rasanya enak dan bisa di konsumsi maka resep makanan ini diturunkan dari generasi ke generasi. *(Sumber: Kompasiana*)

Figure 2. Integration of Sasambo Ethnochemistry in Teaching Materials

Local culture is presented in the form of pictures and short stories about the origins of local culture as a learning resource in the form of applying the concept of colloid chemistry in real life. Next, students can analyse and identify colloid chemistry concepts such as types of colloids, dispersed and dispersed phases, properties, and preparation of colloids. The integration of Sasambo ethnochemistry in teaching materials is developed in almost every sub-chapter.

The suitability of literacy sub-indicators in teaching materials obtained a V index of 87.50% in the very valid category. The suitability of literacy sub-indicators in developing teaching materials is visible at each stage of activities that develop each literacy sub-indicator. The development of teaching materials has been supported by exercises based on Sasambo ethnochemistry to solve real-life problems so that students are expected to be able to explain phenomena using chemical concepts, use chemical understanding in solving problems, and analyse strategies and benefits from chemical applications. The training sub-chapter also has a complete grid and assessment rubric for literacy indicators: context, content, competency, and attitude.

Construct Validity

Construct validity reflects the construction of teaching materials in structure, framework, language, etc. [19]. The construct validity aspects measured are the content, language, presentation, and graphic components.

The results of the construct validity analysis obtained an average V index of 90.7% with a very valid category. The validity values for each component are shown in Figure 3 in detail.

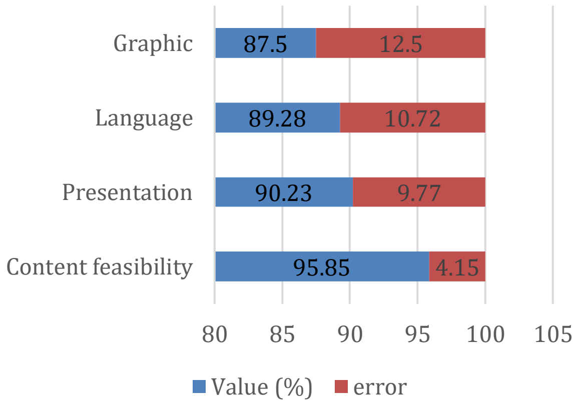

Figure 3. Construct validity values for each component

Figure 3 shows that all aspects of construct validity are in the very valid category, namely the content component of teaching materials with a score of 95.85%, the presentation component of teaching materials with a score of 90.23%, the language component in teaching materials with a score of 89.28%, and the component graphics of 87.5%.

The content component aspect refers to the arrangement of the sequence of material developed by the currently used curriculum. Based on the values obtained, it shows that the teaching materials developed are by the Course Learning Outcomes (CPMK) and sub-CPMK for colloidal chemistry material contained in the RPS and RTM Curriculum 2022 for the Chemistry Education Study Program, FKIP, Mataram University. This is what Purwanto (2006) stated. The content component aspects include the suitability of the material with Core Competencies (KI), Basic Competencies (KD), and the learning objectives students want to achieve [26].

The component aspect of presenting teaching materials with a score of 90.23% is very valid. This means that the presentation of this teaching material has been prepared systematically, coherently, and consistently for each chapter and sub-chapter. The development of teaching materials has also been designed to display PBL syntax as a sequence of activities that students must carry out. Teaching materials also have real problem-solving practice questions and evaluations to measure chemical literacy skills.

The linguistic component aspect related to the use of language in explaining colloidal chemistry received a score of 89.28%, which indicates a very valid category. This explains that teaching materials have been designed using simple, standard, communicative, and straightforward language so users can easily understand them. This is by recommendations from the Ministry of National Education [20] and the results of Rofiah's research [27], which emphasises that the language used in teaching materials should be standard, simple, straightforward, communicative, easy to understand, and by Indonesian language rules. The development of this teaching material also shows that it has been designed according to the student's level of development, has a coherent and integrated train of thought, and uses correct and consistent terms and symbols.

The graphic component aspect is related to the overall appearance or design of teaching materials, such as layout, logos, symbols, images, and illustrations in appropriate and attractive proportions. [28] The panellists' assessment of the graphic component aspect of this teaching material obtained a score of 87.5%, with a very valid category. This shows that the appearance or design of the module is suitable for displaying images from real life, so it is hoped that it can motivate people to read it. The layout of the teaching materials is shown in Figure 4 below.

Figure 4. Lay Out Teaching Materials

The image presentation has a brief description and library sources and can support understanding colloid concepts with an appropriate layout.

Reliability

Measuring the reliability of teaching materials aims to see the certainty or consistency of the assessments of several panellists or the extent to which the results can be trusted. Analysis results in *Inter-Reter Reliability (*IRR) obtained the kappa moment coefficient for each component as in Table 3.

Table 3. IRR Value for Each Indicator

Aspect	IRR value	Reliability Category
Component Head	0.95	Very high
Presentation component	0.88	Very high
Language Components	0.86	Very high
Component Kegraphican	0.85	Very high
Rate Rate	0.88	Very high

Table 3 shows that the IRR value for each indicator, which includes content, language, presentation, and graphics components in the reliability category, is very high. Overall, the IRR value was obtained at 0.88, which means that the reliability of teaching materials is in the very high category. The reliability value shows how consistent the results of the measurement or assessment of the teaching material are. This shows that the assessment results from the four panellists provide consistent and reliable scores on the components of content, language, presentation, and graphics.

Conclusion

Based on the results of the validity and reliability test analysis, it can be concluded that PBL-based colloidal chemistry teaching materials integrated with mechanochemistry to increase student literacy are suitable for learning with a content validity value of 91.36%, construct validity of 90.7% and reliability of 0.88.

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