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Validity, Practicality, Effectiveness: Wetland Contexted-Chemical Representation Module as a Media for Learning

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Abstract

The chemical representation concept is the basis for knowing and understanding chemistry, where it consists of 3 (three) levels, namely macroscopic, particulate, and symbolic. Learning resources with environmental integration and representation concepts are chemical learning media that can strengthen their understanding of learning. However, the chemistry teacher has not been judged to successfully achieve the essence of learning in the science aspect. This study aimed to analyze a chemical representation module contexted-wetland by three aspects (validity, practicality, effectivity). The Plomp Development Model was the research method chosen, but research content focused on to validity, practicality, and effectiveness of product. Especially in effecttiveness, the result also showed how students' understanding to the chemistry and the wetland perspective. Technique, observation, and documentation were the collecting techniques used; Rasch modeling and descriptive statistics used were to find out the symptoms of the data, which was data interpretation; Rasch modeling result was as a preliminary stage in research, then doing others stage (developing context). The finding revealed that the Rasch modeling result demonstrated that person reliability is weak, so it showed that teachers needed to design learning that is suitable and according to student learning needs (preliminary stage). Furthermore, the chemical representation module contexted-wetland assessed worthy (valid, practice, effective) for use in class as a media for learning. The conclusion is developing the media for learning, especially integrating the wetland as local wisdom, chemical representation, and other things that can increase the number of college students because they, college students, are the future. Additionally, this research can be a new reference for teachers in designing instructional media in chemistry learning.

Keywords: Effectiveness; Environment; Multiple Representations; Practicality; Validity; Wetland

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INTRODUCTION

According to (Gilbert & Treagust, 2009), understanding chemistry with the concept of representation is the most appropriate strategy in constructing knowledge to form a good mental model in learning chemistry. In line with understanding (Hand-Dieter Barke et al., 2009), the representation consists of 3 (three) levels: macroscopic, particulate, and symbolic. The particulate level is a vital part in the context of chemical interpretation because they (students) need to use their spatial abilities so that they can understand scientifically the concepts of the material being studied (Hans-Dieter Barke et al., 2012). A deep understanding of chemistry education is essential where it has a more intimate part than the emerging paradigm that chemistry is only part of the scientific aspect (Hans-Dieter Barke et al., 2012). In contrast, chemistry can explain holistically how the universe scientifically (Taber, 2017). That is, ability at the particulate level is the main component of how students construct their mental models to know and deeply interpret the phenomena studied (Hans-Dieter Barke et al., 2012; Darmiyanti et al., 2017). With the concept of collaboration between text, visuals, symbols, and mathematics, this representation concept becomes a mandatory foundation for improving students' problem-solving abilities and training their logic in understanding chemistry (Ott et al., 2018).

Understanding at the representational level to make it easier for students to understand the context of phenomena is part of the process of constructing individual mental models because chemistry is more than just a science (Darmiyanti et al., 2017). The environment is an inseparable part when teachers discuss chemistry (Gilbert & Treagust, 2009). Research by (Levy & Wilensky, 2009) proved the concept of CC1 (Connected Chemistry Chapter 1), where the gas law material and molecular kinetic theory were analyzed how macroscopically the phenomena of an environment were examined in the particulate aspect. Furthermore, (Levy & Wilensky, 2009) added that learning activities with representational concepts could train students to interpret scientifically. It is one the research about the environmental issue. For example, how the environment works through particulate aspects. Knowing the natural environment conditions through dissection of various problems, such as air pollution, environmental damage, energy, and weather, can preserve and extend health and natural environmental conditions in the future. That means that humans can exercise control over the environment and maintain these conditions (Hans-Dieter Barke et al., 2012) The analysis (Hans-Dieter Barke et al., 2012) is reinforced by (Gilbert & Treagust, 2009) that human life is very dynamic and continues to undergo significant changes so ideas are needed in the context of chemical science to achieve natural stability. (Gilbert & Treagust, 2009) added that the environment and human life are closely related to chemistry so exploring phenomena at the particulate level is the right and scientific strategy for making a change.

Renewal in chemistry education is the main thing that all elements, including teachers and researchers, must do, how to develop curriculum, learning design, and the analysis of learning difficulties (Nasir, 2017; Rahmawati & Taylor, 2018). As done by (Nasir, 2017), which is analyzing learning difficulties using the certainty of response index or CRI revealed that there are 74.64% of students experience misconceptions in the practicum data analysis process. Furthermore, students do not understand the concept (3.9%), and 9 % have learning difficulties, especially in determining the topic. Research by (Nasir, 2017) showed that misconceptions and the "difficulty of learning chemistry" persist, so the need for appropriate formulas and solutions reduces or even eliminates the problems described. In addition, (Taber, 2017) also revealed that, in some cases where chemistry was taught by teachers who did not have exceptional skills in chemistry, it affected the optimization of learning. That is, the skills and abilities of a chemistry teacher are one of the main things towards the quality and effectiveness of chemistry learning (Treagust et al., 2003). It is relevant to the condition of chemistry learning, which not only explains and experiments macroscopically but also contributes at the particulate level so that students gain complete knowledge (Hans-Dieter Barke et al., 2012).

Chemistry teachers are the primary key to how curriculum implementation can achieve success indicators in chemistry learning (Hugerat et al., 2015). Teachers in building work professionalism need to agree on conditions that may differ when they carry out their duties as professional teachers, especially how to apply the applied curriculum (Corrigan, 2009). Teachers become one of the important role of improving the quality of chemistry education without leaving the essence of chemistry science (Hans-Dieter Barke et al., 2012). Their perspectives and understanding (teachers) in chemistry education need to change by tracking early on how their cognition and attitudes in interpreting chemistry both in environmental and representational aspects (Hans-Dieter Barke et al., 2012; Özgür, 2018). However, (Hans-Dieter Barke et al., 2012) said that teachers have not successfully achieved science education. Barke considered that the teachers have not successfully achieved success in science education such as chemistry. There is a need for involvement and consistency in increasing particulate understanding. In addition, curriculum development, mental model construction in chemistry education, and how sustainability in the future are essential things (Darmiyanti et al., 2017). Then, the process of changing the students' initial knowledge is also a somewhat tricky part, so the development of appropriate learning resources according to their learning needs is an alternative way to construct their knowledge gradually and undergo transformation (Hand-Dieter Barke et al., 2009; Mezirow, 1991).

Media and the learning process are inseparable. The role of the media is not only as a source of learning but also how the learning media can influence the behavior and mindset of students (Hans-Dieter Barke et al., 2012). The design of this research has three keywords, namely wetland, learning media, and the concept of representation in the research context. Those are one of the drivers for the students, especially prospective chemistry teachers so that the process of training their thinking sensitivity, spatial abilities, and transforming their understanding is not only from the learning process but the presence of appropriate learning media (Hand-Dieter Barke et al., 2009; Rui et al., 2017). Furthermore, the experts considered that the media aspect is not enough to know about how students think. It is needed the representational concept to accommodate it so that teachers can identify students understanding holistically (Gilbert & Treagust, 2009), teaching skills in transferring knowledge and identity as a teacher (Avraamidou, 2016; Mensah, 2016). Additionally, the wetland issue is the main one also in the research; chemistry and wetland have a deep relationship so that students can understand the wetland from a scientific perspective. The scientific perspective has to build on learning to students through the local wisdom issue, which is the wetland. The main reason is students not only understand phenomena, but students can scientifically interpret anything, especially in chemistry learning.

Visualizing the local wisdom contexted-phenomena by instructional media is the best way to help the students getting understand deeply about chemistry dan students' environment. However, most of teachers still teach the students by only chemical content knowledge; they are not connecting the subject with the local wisdom context. So, this research can give the new findings how to use a local wisdom contexted-media for learning to make students easy to get the knowledge and increase students' literacy. Furthermore, the most prominent orientation is how students' understanding shows their sensitivity and knowledge of the surrounding environment, their vision, their interpretation of the context of the wetland environment, and how their representation abilities stand in exploring each case.

The main objective of the research is to analyze the potential feasibility of the product (module) where the feasibility aspect is very much needed in the context of development research (Korniawati et al., 2016; Nurhasnah et al., 2020; Wahyuni & Yerimadesi, 2021; Yuliati, 2013). Validity, practicality, and effectiveness are three criteria that must be presented in the discussion of a development. These criteria are very necessary so that the products developed are representative of the issues raised. This research explains not only the criteria mentioned, but also describes how students' perspectives on chemistry and the context of wetlands are described. The product result can be stated as a product that is valid, practiced, and effective. This research is also giving a simple strategy offering how to conduct an early analysis of students' readiness (prospective teachers) in teaching using the concept of representation and their scientific perspective on the wetland environment. The research problem formulation is whether the product development carried out is valid, practical, and effective? including a description of their understanding through their responses to the issues given.

METHOD

The research method used Research & Development (R&D), but this research focuse on analyzing the validity, practicality, and effectiveness of the product (module). Those are very important in developing a media like module. On the other hand, effectiveness is one of the criteria focused on in this research. the aim is to find out to what extent the level of students' understanding of chemical and wetland content. Rasch modeling is also used at the beginning to track students' initial understanding so that the products developed are relevant to students' cognitive levels. To begin with, the study analyzed how to develop the module as an instructional media in teaching. Furthermore, before doing the developing process, students' abilities were measured by Rasch modeling. It is a preliminary stage where it aimed to know the description of the cognitive abilities of students in SMA Banjarmasin. The Rasch model data symptom results were used as guidelines in developing products (wetland chemistry modules). In addition, it was also used for designing the concept of chemistry learning, where the analysis of the Rasch model was considered very effective and representative as a reference in developing a chemistry learning product (Sumintono & Widhiarso, 2015). The main project was developing the product (chemical representation module contexted-Wetland) using the Plomp model (Herdini et al., 2018; Rosalina Rawa & Sutawidjaja, 2016). In addition, what is highly emphasized is how the description of the chemical representation module contexted-wetland was developed by three aspects, which are validity, practicality, and effectiveness. Especially in the effectiveness aspect, the finding shows the student representation understanding and environmental aspects are integrated completedly.

The data collection technique used was a test technique using multiple-choice questions analyzed using the Rasch model. The learning outcomes were analyzed using standard statistical analysis, namely using the N-gain formula to see how their understanding progressed even though the N-gain value was not entirely determined to explore. It means that the presentation of research results involved a lot of data, the views of researchers, the results of previous research, and other studies that are relevant to the investigation. The instrument used is a multiple-choice test instrument when analyzing the Rasch model and understanding the issues designed using an essay test instrument. The essay was in a series of cases in the developed module. Indirectly, the products produced are expected to be the suitable learning media in constructing students' knowledge, especially prospective educators, to understand and explore the role of chemistry education which was not only part of science.

RESULTS AND DISCUSSION

Environment and science are elements that could not be separated either in implementation or scientifically. It was shown by (Gilbert & Treagust, 2009) that aspects of chemistry are always present in the context of environmental phenomena around humans; even students are encouraged to have visual abilities and or abilities at the particulate level in understanding chemistry. Knowledge at the particulate level not only makes students' understanding more concrete but also trains their reasoning power and thinking sensitivity to life so that they can quickly examine and interpret events that occur (Hans-Dieter Barke et al., 2012). The research results will undoubtedly be one of the studies and evaluation materials in teaching and learning chemistry. Teachers (teachers/lecturers/researchers) can use the results of this research as an additional supplement in assessing students' thinking skills today.

In connection with the above, the symptoms of the interpreted data are a form of visualization of how the relevance between students' abilities and development products. It includes the ability of teachers and the distribution of statistical values found. Data summary statistics on Rasch modeling found that Person Reliability in the table is 0.70. While Item Reliability is 0.97, meaning that it can be concluded that the consistency of the answers from students is weak (<0.76 = Weak), but the quality of the items in the instrument has reliability "good" (0.8-0.9 = Good). When viewed from the "scalogram", the average student can answer the questions given. However, the weak response consistency shows that students still experience an inconsistent understanding of the basic chemistry concepts or potential misconceptions. The item indicates that the instrument is in the "good" category with a value of (0.97). Summary statistics by Rasch Modeling are shown in Figure 1.

SUMMARY OF 455 MEASURED (EXTREME AND NON-EXTREME) Person

	TOTAL SCORE	COUNT	MEASURE	MODEL ERROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	7.9	25.0	-.99	.51				
S.D.	4.4	.0	.98	.13				
MAX.	21.0	25.0	1.84	1.84				
MIN.	.0	25.0	-4.64	.42	.69	-2.4	.43	-2.3

REAL RMSE .53 TRUE SD .82 SEPARATION 1.53 Person RELIABILITY .70
MODEL RMSE .52 TRUE SD .83 SEPARATION 1.58 Person RELIABILITY .72
S.E. OF Person MEAN = .05

Person RAW SCORE-TO-MEASURE CORRELATION = .98
CRONBACH ALPHA (KR-20) Person RAW SCORE "TEST" RELIABILITY = .77

SUMMARY OF 25 MEASURED (NON-EXTREME) Item

	TOTAL SCORE	COUNT	MEASURE	MODEL ERROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	143.9	455.0	.00	.12	1.01	-.5	1.07	-.2
S.D.	54.2	.0	.75	.02	.15	2.5	.31	2.4
MAX.	238.0	455.0	1.76	.18	1.34	3.9	2.15	4.1
MIN.	39.0	455.0	-1.12	.10	.82	-5.5	.77	-4.6

REAL RMSE .12 TRUE SD .74 SEPARATION 5.93 Item RELIABILITY .97
MODEL RMSE .12 TRUE SD .74 SEPARATION 6.21 Item RELIABILITY .97
S.E. OF Item MEAN = .15

Figure 1 Summary Statistic by Rasch Modeling

Based on the data presented, either the "summary of statistics" above or the data analysis of the previous Rasch model described, it has provided information for researchers that it is necessary to design learning that is suitable and according to student learning needs. The planned learning strategy is to develop chemistry module products composed of concepts that can train their thinking skills. In addition, the material made in the product development concept is acid-base material, where acid-base material is a material that is quite closely related to the idea of human life. Another reason is that the researchers raised the theme of "wetlands" to understand that the context of science is broad and covers all aspects of life. It is also reinforced because the wetland context has excellent potential to be integrated into the acid-base concept.

Based on the summary of statistics above and the previous Rasch Modeling data, it provides information necessary to design learning that is suitable and according to student learning needs. One of the planned learning strategies is developing a chemistry module product composed of concepts that can train students' thinking skills. In addition, the material made in the development product is acid-base material, where acid-base material is a material that is quite closely related to the concept of human life. Another reason is that the researchers raised the theme of wetlands to understand the broad context of science, including the paradigm that chemistry is very relevant to aspects of life. It is also reinforced because the wetland context has excellent potential to be integrated into the acid-base concept.

Validity Test

The image below is a recapitulation of the product development validity tests carried out. The data recapitulation shows the level of validity of the development product, namely, the Wetland Chemistry teaching module on acid-base materials. The validation results based on the data below are guidelines in stating the feasibility level of the developed product. Overall, the product produced is declared valid (valid) either the product or the instrument used in the research. The validity of the developed product is shown in Figure 2.

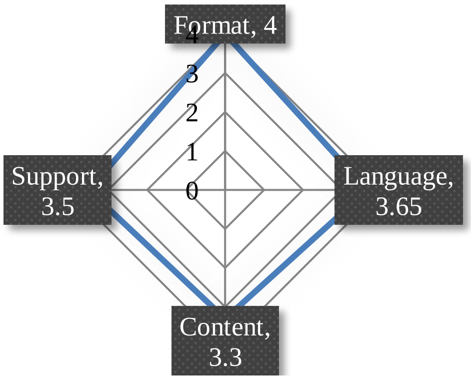


Figure 2 Product Validity Developed

Practical Test

The feasibility of the product is seen from the feasibility aspect according to the requirements required (valid, practical, effective), but how the product can affect the scientific perspective of students. In addition, students are expected to understand that local wisdom is part of science so that learning chemistry is no longer a material that is considered complex and challenging. Product implementation results are shown in Figure 3.

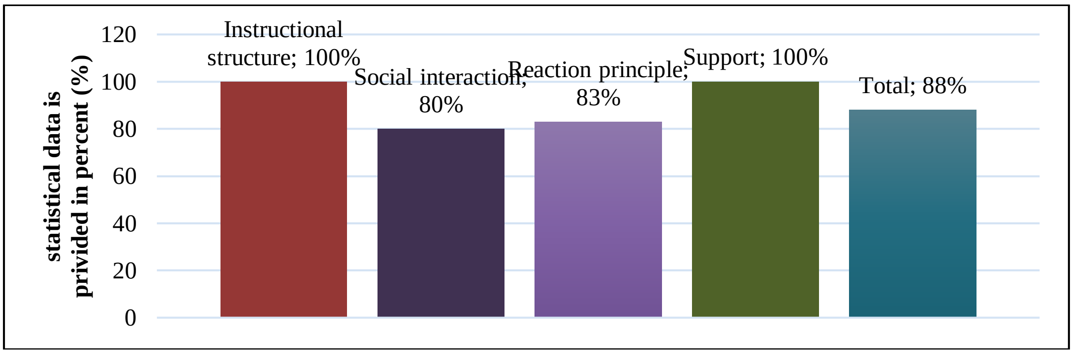


Figure 3 Product Implementation

The results of statistical data analysis revealed that teachers could carry out chemistry lessons according to the planned concepts and use wetland-based chemistry modules. It means that the module developed can be optimized as a renewal in training students' critical, creative, innovative, and scientific thinking skills considering that chemistry needs the right reasoning power to understand. With the concept of representation, students experience learning chemistry scientifically, but they have indirectly interpreted local wisdom as part of scientific studies. In addition, the representative idea is one way of knowing the level of students' understanding at the particulate level. It is not just practical in terms of product eligibility requirements, but the impact that students can feel, such as students being able to interpret in-depth the cases offered in class and the completion process. Scientifically. Results description of data: how teachers manage the learning process is shown in Figure 4.

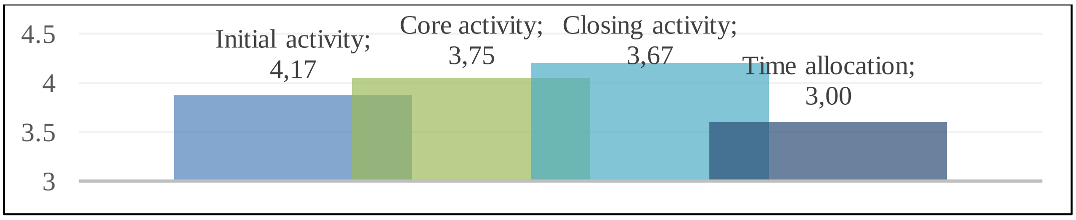


Figure 4 Data Description: How Teachers Manage The Learning Process

Figure 4 shows that teachers' ability in class management is the most important part, especially how teachers are doing the treatment to students, and figure 4 reveals that teachers' activity during the learning process is at a good point. It is been shown that teachers can manage the learning process according to the results gotten. The ability of teachers to manage the learning process is part of the feasibility aspect of product development. Previously, the product implementation data has been explained, then the teacher's ability to manage to learn focuses on how the teacher's ability to drive learning. In addition, how the teacher uses the product during the chemistry learning process so that the observer becomes easier to analyze the teacher's ability in the context of teaching.

Figure 4 shows that the ability of teachers to manage the learning with products is a very high criterion except for the aspect of time allocation with the "high" criteria, where almost every part of observation meets the requirements (teachers ability) 3.5 (note the value on the graph). The criteria obtained based on Figure 4 show that the classroom management by the teacher using the product is stated to be appropriate and according to plan. In addition, the indicators used are very representative of the assessment in this aspect. The wetland-based chemistry module is not just a learning resource or additional reference in learning chemistry. Still, with this product, teachers can train students' spatial abilities and reasoning power at the particulate level. Then, the teacher succeeded in stimulating the students that learning the concept of chemical representation helped them interpret chemistry, especially the integration of wetlands in education. It proves that the scope of science is extensive, especially in learning chemistry, where they can learn chemistry from various perspectives.

Limited Test (Effective Aspect): Particulate Level Understanding Analysis & Wetland Study

The initial test carried out was to distribute wetland-based chemistry modules in chemistry learning. Students are the initial targets of this trial because they are assessed as agents of change for reform to occur in schools. In addition, students are prospective teachers or called "prospective teachers," so the treatment given trains their skills and mentality as future teachers. The trial was conducted on those (students) who had taken school chemistry course one and were undergoing the school chemistry course 2. The test was carried out to review the effectiveness of the product and treatment in the learning process, trying to be natural without any nuances of control in the classroom. Learning in this class is not focused on the product and how it changes but instead emphasizes how the product (teaching materials) can contribute new perspectives and influence their mindset. In addition, the outcome of the wetland chemistry module also adopts the concept of representation so that the product developed is relevant to scientific studies. It means that apart from reviewing the context of local wisdom (wetlands), students also interpret representation-based chemistry content, especially at the particulate level.

Johnstone (1993) revealed that studying chemistry requires three levels of understanding: macroscopic, particulate, and symbolic (Hand-Dieter Barke et al., 2009). Chemical multi-representation is a mandatory concept that students as prospective teachers must know, where the negative paradigm about chemistry is that chemistry is abstract, difficult to understand, and other reasons that seem to generalize that chemistry is an elusive material (Becker et al., 2015; Bruce et al., 2016). On the other hand, chemistry is part of the environment where every aspect of human life is always in science (chemistry) (Gilbert & Treagust, 2009). In terms of content, chemistry looks complicated, so the alternative for teachers is to study and analyze chemistry based on *"complex problem solving"* such as integrating the environment, natural phenomena, and humans into the chemistry learning process (Hans-Dieter Barke et al., 2012; Normalasarie & Aulia, 2019). The integration of the environment can change students' perspective that natural chemistry is broad and very in touch with the environment. This perspective needs to be observed by prospective teachers so that students in the school environment are more familiar with chemistry according to the context (Hans-Dieter Barke et al., 2012). This wetland-based chemistry module describes that the environment is an inseparable part of chemistry to have a more scientific understanding.

The table below is a recapitulation of the overall N-gain value. The average N-gain obtained is 0.51. This value of 0.51 indicates the "moderate" criteria, meaning that the treatment given can increase the specified criteria. The knowledge aspect increase shows how far the students experience changes in understanding the chemical material presented through the developed product and with the relevant learning concepts (adoption of representation concepts) given in class. Giving assignments and pieces of training such as solving case-based questions will train memory skills, reasoning power, spatial abilities to the concepts being taught, and motivation are part of the treatment given. The test used to measure the increase in learning outcomes assesses how the teacher sees students' cognitive development from what has been provided, including the assignments described. Data recapitulation of n-gain learning outcomes (cognitive) is listed in Table 1.

Table 1 N-gain Data Recapitulation of Learning Outcome (Cognitive)

No		Average	N-gain average
1	Pre-Test	61.58	0.51
2	Post-Test	85.09	

In connection with the above, the proof of the moderate category (N-gain=0.511) is related to Figure 5. Although the N-gain value is 0.51 with the criteria of "medium" where the students experienced an improvement in the learning process, the matter indicates that the treatment given makes students experience changes, especially in the cognitive aspect (knowledge). Figure 5 shows the students who experienced an increase of 18.91% with moderate criteria. This "medium" criterion, even the percentage on the low criterion of 35.13%, shows that overall the students or students of chemistry education are still low in analyzing the cases presented. Although, on the other hand, researchers consider that the treatment given during the learning process has had a reasonably practical impact. The average results of N-gain learning outcomes (cognitive) are shown in Figure 5.

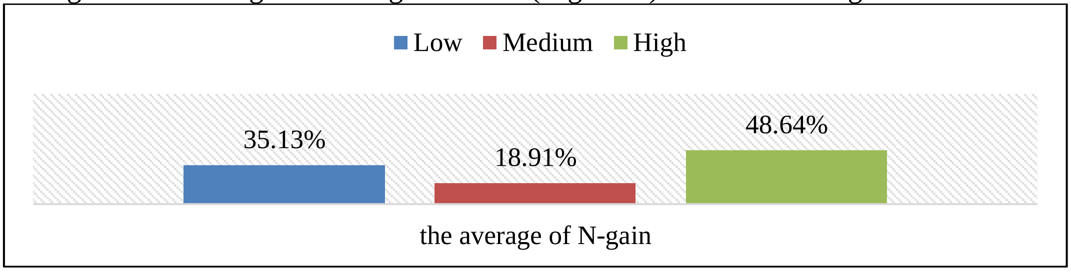


Figure 5 The average of N-gain of Learning Outcome (Cognitive)

Figure 5 reveals that every student has different improvements in the learning process by using the product developed. The most stand out N-gain according to figure 5 is 48.64%; it describes that the products developed have affected students' cognitive improvement. Additionally, students' understanding is also the main element in how to assess the effectiveness of the product being developed. Their understanding is about representational concepts and how they find the correlation between chemical representation and wetland—then related to the chemical representation. The basic idea of chemistry is how the students analyze the problem by using their particle ability. The students will show their understanding and interpretation (Hans-Dieter Barke et al., 2012). (Ryan & Herrington, 2014) says that *"Understanding what happens at the particulate level when ionic compounds dissolve in water is difficult for many students, yet this understanding is critical in explaining many macroscopic observations."* Misconceptions often occur because they do not have abilities at the particulate level so they have difficulty interpreting macro and symbolic (Hans-Dieter Barke et al., 2012).

The above statement is reinforced by (Kelly et al., 2010) that chemistry learning can only be interpreted accurately and scientifically if they have reasoning and interpretation skills based on particulate levels (macroscopic, sub-microscopic, and symbolic). Suppose it is related to the results of the research conducted. In that case, the graph showing the moderate criteria with a value of 18.91% indicates that the students do not fully have representational competence, so deeper strategies are needed to forge students' cognitive abilities, especially those oriented to the representation level. The description of the statistical data symptoms described earlier that their condition (students) are still assessed has a low-level understanding of the material presented. This symptom is then reinforced in explaining the students' writings on the cases discussed based on cases #1 and #2. The teacher gives several issues that are very relevant in practicing their thinking skills during the learning process. The result shows that the issues given are very representative in assessing their understanding and make it easier for teachers in increasing the quality of learning. It means that strategies are needed to improve their understanding and thinking skills.

The strategy in question is to increase both theoretical and experimental exercises so that the concept of multi-representation level can be internalized by students (Gilbert & Treagust, 2009). Another research shows that the concept of hands-on activity support students in sharpening particulate level abilities. In that research, the product made uses a problem analysis approach based on the representational triplet in chemistry; it is for sharpening the scientific understanding that was previously owned. that statements same about what the product developed goals, where students have to analyze compounds to the level of chemical structure, orbital energy, electronegativity, and chemical bonding processes so that students can interpretative phenomena in a scientific way.

Case #1: stability analysis with particulate level, shown in Figure 6

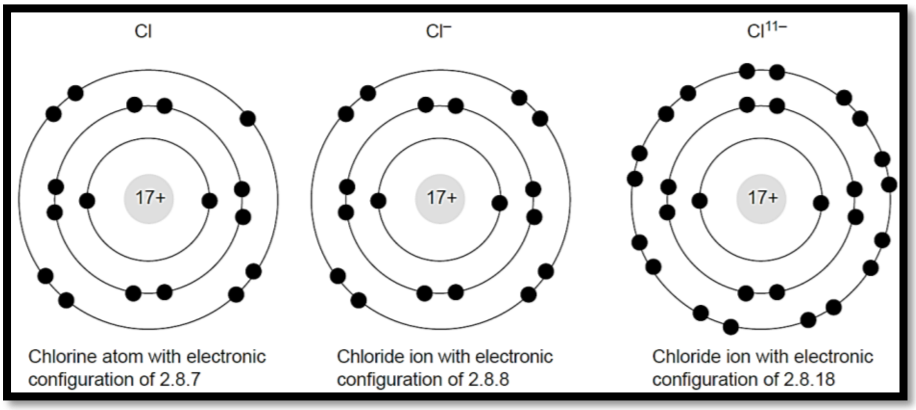
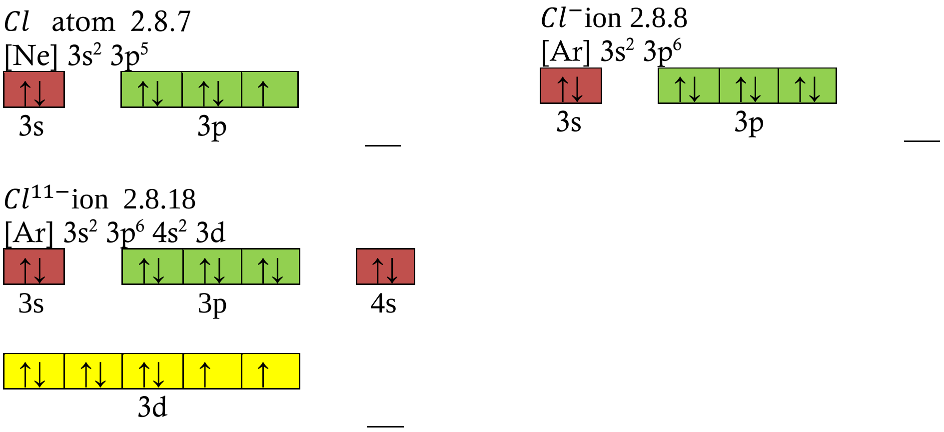


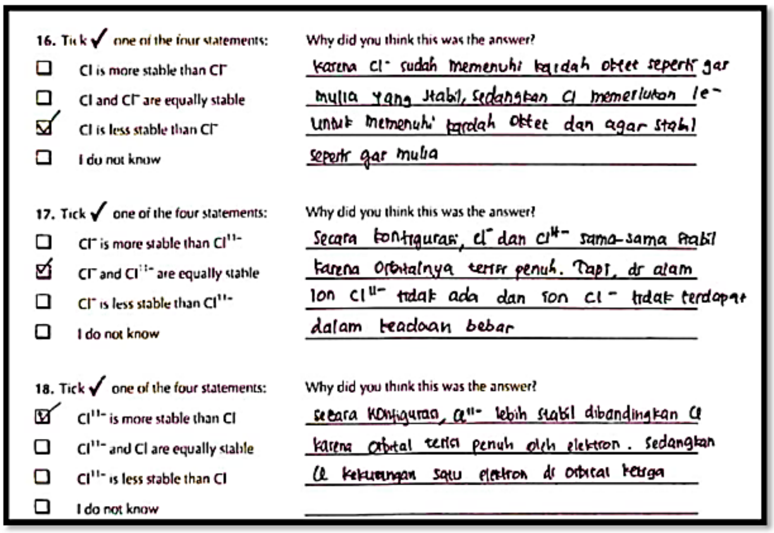
Figure 6 Case #1 is Cl atom stability (Taber, 2002)

Figure 6 is a case given to students as a form of analyzing their particulate level abilities. This case is taken from a book (Taber, 2002) entitled "*Chemical Misconceptions_ Prevention, Diagnosis and Cure*" to measure the depth of thinking of students regarding the level of particulate matter in question so that the case presented is very representative of the purpose of the researcher's analysis. The reasons explained by the students showed that they could scientifically explain various reasons based on the cases presented. The reasons are as follows:

- Reason # 1: Cl is less stable than Cl^{-} because Cl^{-} is appropriate with octet rule like noble gases, while Cl needs one electron for fulfilling the octet rule and stability.
- Reason # 2: Cl^{-} and Cl^{11-} equally stable because of their orbital configuration fully and Cl^{11-} does not exist in nature, and Cl ions⁻ are not contained in a free state in the universe.
- Reason #3: configurationally Cl^{11-} is more stable than Cl because the orbital is filled with electrons, while Cl is missing one electron in the third orbital.



The reasons above are the students' answers to case #1. This answer reveals students' learning progress; it can be an evaluation for the teacher. It is to see the student's growth in the learning process. The students' responses above were considered quite scientific, although they still needed to explore their answer patterns, considering that they were students who had experienced a lot. Case #1 above shows students need to integrate the concept of electronegativity in addition to the idea of octet or stability. The visualization of student answers according to case #1 is shown in Figure 7.



16. Tick ✓ one of the four statements:
- ☐ Cl is more stable than Cl^-
- ☐ Cl and Cl^- are equally stable
- ☑ Cl is less stable than Cl^-
- ☐ I do not know

Why did you think this was the answer?
karena Cl^- sudah memenuhi kaidah oktet seperti gas mulia yang stabil, sedangkan Cl memerlukan 1e- untuk memenuhi kaidah oktet dan agar stabil seperti gas mulia

17. Tick ✓ one of the four statements:
- ☐ Cl^- is more stable than Cl^{11-}
- ☑ Cl^- and Cl^{11-} are equally stable
- ☐ Cl^- is less stable than Cl^{11-}
- ☐ I do not know

Why did you think this was the answer?
Secara konfigurasi, Cl^- dan Cl^{11-} sama-sama stabil karena orbitalnya terisi penuh. Tapi, di alam ion Cl^{11-} tidak ada dan ion Cl^- tidak terdapat dalam keadaan bebas

18. Tick ✓ one of the four statements:
- ☑ Cl^{11-} is more stable than Cl
- ☐ Cl^{11-} and Cl are equally stable
- ☐ Cl^{11-} is less stable than Cl
- ☐ I do not know

Why did you think this was the answer?
secara konfigurasi, Cl^{11-} lebih stabil dibandingkan Cl karena orbital terisi penuh oleh elektron. Sedangkan Cl kekurangan satu elektron di orbital ketiga

Figure 7 The visualization of students' answers according to case #1

Reason #1 is good enough but their explanation needs to be much deeper in interpreting case #1. Regarding the halogen elements, the word halogen was introduced in 1811 to describe the ability of chlorine to form ionic compounds with metals, namely salts (Petrucci et al., 2011). (Petrucci et al., 2011) added that halogens exist as nonpolar diatomic molecules explaining the relatively low melting and boiling points. Chlorine is a halogen element that has a high electronegativity of 3.0 with a small atomic radius. That is, the students must identify how to place halogen elements such as Cl under various conditions including electronegativity. Electronegativity is not part of the nature of atoms but is only a property of atoms in molecules. The property of a single atom that is equivalent to electronegativity is electron affinity. The electronegativity of an element will vary depending on the chemical environment but is usually considered a transferable property, i.e. a value of electronegativity is assumed to apply in a variety of situations.

Another fact is that the stability theory is based on the octet rule that the tendency of other elements to reach a stable configuration of noble gases (valence electrons 8) is called the law *octet*, while the tendency to achieve stable configurations of noble gases (valence electrons 2) is called the law *duplet*. An atom can achieve a stable electron configuration of a noble gas atom by giving up electrons, accepting/gaining electrons, and sharing an electron pair. That is, the concept of stability based on case #1 has many theoretical perspectives to scientifically justify the case Cl above, not as simple as the student explanation they made.

Reasons #2 and #3 show that they have a misconception in interpreting the Cl^{11-}ion by writing that the Cl^{11-}ion stable because in configuration, the orbital condition is filled. If you pay attention to the description of the orbitals above, the state of the Cl^{11-}ion orbital in the 3d shell is neither half-full nor full. The analysis that is closest to why they give this statement is because they pay attention to the electron configuration of the Cl^{11-} shell, which is 2.8.18. then, they judged that the condition of the electron configuration of the shell was very close to that of the noble gas so they gave such an answer. They have enough time to conduct reference analysis and discuss so that the response given is much more scientific. That is, the proof of stability through the electron configuration of the subshell at the orbital level can be the key to case #1, especially the Cl^{11-}ion.

The explanation above shows that students' answers to case #1 are still considered unscientific and even wrong in theory. This condition shows the importance of adopting the concept of chemical representation so that the students not only know the material but they can interpret the material in-depth, especially at the particulate level. That is, ideally they should explain in a representational way so that their explanation is much more scientific and accurately describes and interprets case #1. The study through the concept of representation is a learning method to find out the depth of case #1, especially case #1 shows an example of Cl^{11-}ion which is unusual in a scientific concept. That is, case #1 is the teacher's strategy to find out how the cognitive structure and mental model of students in analyzing case #1. The visualization of wetland context and chemical perspective is shown in Figure 8.

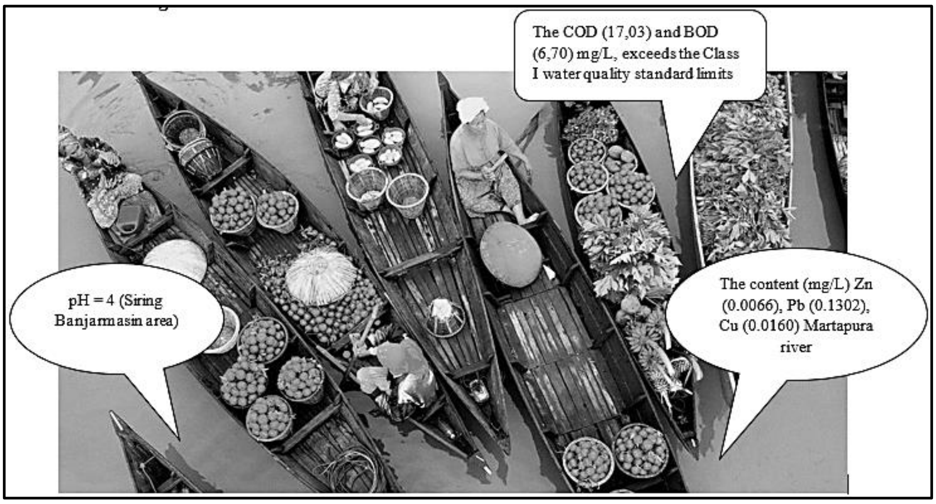


Figure 8 Visualization of wetland context and chemical perspective

The descriptions below are the student's responses which it is taken from the student's analysis according to the issue given:

a. Describe and write down your understanding of the term "**wetland"?**. *Students' response: Wetlands are areas where the soil is saturated with water, permanent or seasonal. Wetland areas are usually flooded by shallow water and last for a long time. Wetlands are very abundant in the Kalimantan area.*
b. Write and explain the relationship between chemistry and wetlands?. *Students' answer: Chemistry is a branch of science that deals with the structure, properties, and chemical changes of a substance and the energy changes. So, the relationship is that wetlands are included in the study of chemistry. In wetlands, we examine their properties, levels or content of substances in them, pH, etc.*
c. How does acid-base material present in the context of wetlands, or how would you explain wetlands in terms of the material being studied (acid-base)? *1) Students' answers: wetlands are acidic, so they use the acid-base principle, for example, on peatlands that are intended to be used for farming; The land is first burned so that the ash from the burned plants will neutralize the pH of the soil, and the ground can be planted, 2) we can research or conduct experiments by measuring the pH of water from various sources, such as several different areas or different river water, 3) By explaining the two components of water and soil. In water, there are various substances contained in it which is an example of the context of the wetland in question.*

d. What can the contribution be implemented to the community regarding wetland studies through learning chemistry?. Students' answer: *1) we inform that the community needs to know the appropriateness of the water contained in the river and how it affects them, dan 2) the community can know the use of wetlands by using the acid-base principle so that the community can optimize peatlands in the agriculture and fisheries sector*

Case #1 (figure 6) and case #2 (figure 8) are the impacts of learning applied in class, where the concepts are compiled using the idea of chemical representation by prioritizing the particulate level in analyzing cases. Even though the material for the chemical module is based on acid-base wetlands, the researchers deliberately arranged instances that did not directly intersect with acid-base materials. This method aims to make students accustomed to practicing their thinking skills in interpreting cases scientifically, meaning that they are no longer in the realm of knowing aspects but how to interpret issues in depth.

Figure 6 is the initial stage of knowing how far students understand the case, which is then solved at the particulate level. After the representation-based points, a wetland context-based case was presented (figure 8), where they were left to explore the wetland case and review it from a chemical perspective. Psychologically, they should know the term wetland context in-depth so that when they explain the context in terms of chemistry, they should present it more precisely and scientifically.

Theoretically, the students are rated low in interpreting case #1. This can be seen from the pattern of their answers in case #1; their answers are far from the expectation in terms of understanding the particulate level. Then, case #2 is in the context of wetlands and chemistry. Case #2 consists of 4 questions that lead students to indicate the extent of their scientific knowledge and its relevance to the wetland context. The average answer of the students in number -a- was considered a reasonably good and standard answer because they answered that wetlands were areas that were inundated with water with permanent or seasonal conditions. This student's answer is quite representative of understanding the term wetland context. They fully understand that South Kalimantan is a province with wetland characteristics with the understanding described previously.

Their answer to the question -b- is fascinating even though the answer is quite simple. On average, they answered that chemistry is a science that broadly discusses the nature of a substance and its energy changes; where the relationship with wetlands is that in the context of wetlands, chemistry plays an important role, such as with chemistry, people can know the content and content of water, soil, and the environment in South Kalimantan. In addition, they also mention that pH is part of a wetland which is then very relevant to chemistry.

The answer to the question -c- contains many inaccuracies; for example, they say that "wetlands are acidic" (c1). This statement may be true when they write down precisely and scientifically why they make such a statement. However, they continued that burning is the first step that must be done before the community starts planting because they understand that the charcoal left from burning can fertilize and neutralize soil pH levels. While c2 and c3 answers contain irrelevant answer content and have no relationship with the question, the researcher does not fully understand the questions presented.

Questions -d- presented from the answer of d1 and d2 contain answers that are also considered to be less focused and inappropriate to the questions raised. At their cognitive level, they should have answered much better and at least focused on the question, "what contribution can be implemented to the community regarding wetland studies through chemistry learning?" From the context of their answers, it can be seen that they have difficulty in two things, namely the explanation of scientific content, language, and how to communicate the answers in written form so that their answers tend to be out of focus.

Overall, the students did not fully understand the content of chemistry either at the particulate level or understanding the wetland context. The structure of the answers they presented seemed that they did not make an effort to interpret the cases given. In fact, in the learning process, the teacher has shown the variety and pattern of learning chemistry based on the right representation and wetland material in learning chemistry is not the first time it is given. Previously, he had analyzed wetlands on the buffer solution material which was then linked to environmental issues, namely "*plastic bags*". The results obtained are quite similar to the cases discussed in this case in that they have not optimized their ability to solve cases.

Concretely, this research is an innovation in the teaching of chemistry. Representation-based chemistry teaching is a fundamental concept of how to understand chemistry scientifically. In addition, the integration of the environment becomes complementary considering that there are many negative thoughts about chemistry in terms of content and technical studies. This research can be used as a reference in analyzing students' understanding, especially in universities. In addition, Figure 9 is the main component that is recommended based on the research results found. It means that teachers can use these results as the basis for analysis before starting and planning class lessons. Then, researchers can continue this research to find new findings so that the solutions found can gradually reduce misconceptions in the field. (Hans-Dieter Barke et al., 2012) Explains that students need to transform cognitively by solving a problem to have a suitable mental model of the phenomenon. Improvement of mental models will change their preconceptions into scientific concepts in learning. The following is a strategic plan that will be carried out so that the conditions described can change gradually, where teachers need to continue to innovate and be creative in developing learning concepts and products that offer renewal in learning chemistry. In addition, updates also need to be made on the developed products (chemical-based chemistry modules) by conducting discussions with the team and experts to revisit related products. Below is the recommendation for the teacher to arrange the teaching. The learning strategies recommendation for teachers to improve the quality of learning & students' comprehension is shown in Figure 9.

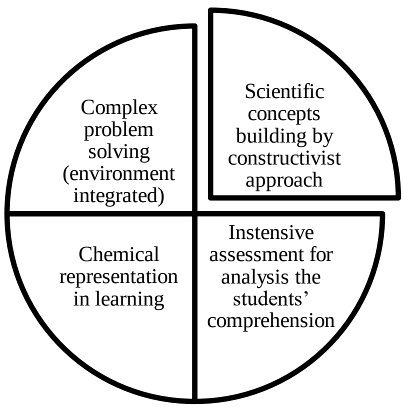


Figure 9 Learning Strategies Recommendation for Teachers to Improve the Quality of Learning & Students' Comprehension

The Visualization of Module 1 is shown in Figure 10.

Figure 10 The Visualization of Module 1

The Visualization of Module 2 is shown in Figure 2.

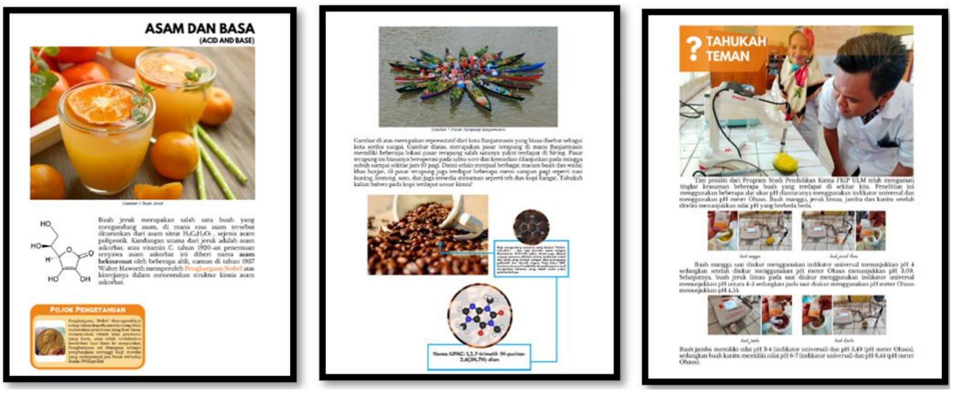


Figure 11 The Visualization of Module 2

CONCLUSION

As a result, the resulting product has met the eligibility requirements (valid, practice, effective) even though, the product still needs to be revised contently. Then, students experienced progress even though it was very small progress. The result also showed that in the future, teachers have to prepare such as assessment of learning, media, and learning concepts, especially how to shape the character of the teacher in the teaching process. According to the findings obtained, it is can be concluded that developing chemical representation contexted-wetland is worthy as an instructional media in teaching or media for learning. In addition, the findings, especially the learning strategies explained, reveal that developing the learning resources such as media and an idea (strategies) are very important in the teaching context. Through wetland integration in chemistry learning, chemistry material can be easier to understand for students so teachers need to develop anything that can increase students' ability and teaching and learning quality.

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