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PROJECT-BASED ACID-BASE EXPERIMENTS TO IMPROVE VOCATIONAL HIGH SCHOOL STUDENTS’ MULTIPLE REPRESENTATION ABILITY

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INTRODUCTION

Chemistry education at pharmacy vocational high schools (SMKF) was an adaptive program subject. Adaptive program was a group of subjects of education and training which served to form the learner as an individual, in order to have a broad and solid knowledge. The goal of adaptive program was preparing students to adapt with changes in the work and social environment that make them to develop themselves in accordance with the science development, technology and art [2]. Besides, adaptive subject was also support and develop students’ concept mastery and skills on their competencies according to their expertise.

Those demands become the basic importance in giving chemistry lesson that can develop students’ concept mastery to support students’ competencies. Chemistry concepts consist of three level of chemical representation (macroscopic, symbolic and submicroscopic). Students’ knowledge in chemistry generally was not connecting these three levels of representation so that student’s comprehension of the concepts will be fragmented and students may only learn the concepts’ as recitation [5]. In fact, generally chemistry teaching has not yet developed those three levels as a whole, thereby inhibiting the ability of students to solve problems [6]. Regarding of these obstacles, it is very important to develop the ability of students’ multiple representations, especially students of vocational skills programs as a preparation for understanding the pharmaceutical chemistry and improve their ability to solve problems both in work and life environment.

One of the chemistry subjects that require multiple representations is acid base properties. These concepts was very supportive to make drugs in pharmaceutical preparations used in productive subjects of recipe knowledge. The problem arose was...
laboratory experiments only results in recitation only, and was not in line with the demands of competency standards of Pharmacy Vocational High School. The lesson that made students able to use multiple representation abilities in a comprehensive way that needed and become an alternative that can be used in project-based acid-base experiment.

Project-based learning was model of pedagogy that engaging students in learning knowledge and skills through the process of finding or extracting (inquiry) using authentic questions, to make products ranging from planning, designing, producing and reflect the creation of the product, that students experience the learning more interesting and meaningful [3]. This was in accordance with the vocational competency standards that equip graduates to have the ability needed for both their life and work environment. Project-based learning is expected to increase students' understanding of chemistry concepts. Students' concepts comprehension can be constructed well if students are able to develop a relationship between the phenomena with the taught concepts through their mental models.

Based on the background mentioned before, this study assessed the ability of multiple representation that built up through project-based acid-base experiment.

**METHOD**

The method used in this study is quasi-experimental with pretest-posttest, nonequivalent control group design. This study was conducted in one of the Pharmacy Vocational High School, consist of 30 students in experimental class and 31 students in control class. The instrument used in this study is test item of multiple representations abilities and questionnaire were used to determine the responses of teachers and student toward learning model applied. Data processing is performed by SPSS 20 software, MS Excel 2010 and Anates.

Project-based acid-base experiment generally consists of three stages as adapted from The George Lucas Educational Foundation (2005). The first stage was goals design and inquiry aspects stage, at this stage the students identify the society’s widely spread drug with acid-base compound, the efficacy of the drugs, identify the type of acid-base solution used, any acid-base concept that emerged, and how to make the drug dosage in the school laboratory. Students made observations and seek information from various sources about the upcoming project and before the observation made, the student was given discourse in advance of the drugs associated with acid-base compounds.

Giving the discourse was expected to lead the students to formulate issues for designing purposes and provide apperception that many acid-base compounds used as raw material for making drugs. And then, students were asked to determine the major topics and give examples of acid base compounds suitable with Arrhenius, Bronsted-Lowry and Lewis acid-base theory with those multiple representations. Students were asked to discuss in advance about the theory of acids and bases before doing observations as preliminary knowledge when searching for acid and base compounds.

Furthermore, students observed and classified drugs in communities that using acid-base compounds and its efficacy. Students discussed to analyze the concept of acid and base properties that arose from observed drugs and included its multiple representations.

The second stage was project design stage, there students fill out a guide for the project design contains the problem formulation, alternative solutions, equipment and materials preparation, work procedures, reflective with teachers, and discussions to determine the best solution. Students were given the problems with the aim to explore their critical thinking disposition ability. The problems given was how to identify acid-base compound that the drug contained, calculate the compounds acidity degree (pH) in drugs.
preparations, the procedures for making drugs preparations syrup and its pH measurement, the maximum dose calculation based on the recipe given, assay of the drug’s active substance.

Students were required to actively ask questions and discuss the procedure design that was assigned suitable with the literature that has been used, anything that can be used for the design, acid-base concept that appears on the chosen drugs, how to identify, calculate, and assay the acid base compounds. Of the problems given the students were asked to consider the best solution to be used at a later stage.

The final stage was implementation and evaluation stage. Students doing project activities in accordance with the design during the implementation stage of the project. The students’ experiment start with analyze the acid-base compounds properties in the chemistry laboratory, calculating and measuring the acid-base pH, carrying out the manufacture of drugs in accordance with procedures that have been designed and maximum dose calculations in the recipe laboratory, check the amount of active substance in the chemistry laboratory.

In the evaluation stage, students presented the results and assessment for reports, product and students performance assessment during the project activities and its multiple representations. Students conduct discussions about the properties contained in the drugs, calculate and measure of acid-base compound pH in drugs preparations, the design of the tablet-making procedures and drugs pH measurement. They count maximum dose based on the recipe given, and assay of the active substance in the drug through acid-base titration.

Acid-base concept that emerged in the drug and drug-making process include acid-base theory (Arrhenius, Bronsted-Lowry and Lewis), acid-base properties, ionization degree, acidity degree, neutralization reaction, hydration, hydrolysis, buffer solution, and acidbase titration.

RESULTS AND DISCUSSION

Data Analysis

The students’ multiple representations ability on macroscopic, symbolic and submicroscopic representations’ achievement is analyzed based on pretest, posttest scores results and% N-gain between the experimental class and control class that are shown in Table 1. N-gain percentage value indicates increased ability in macroscopic, symbolic and submicroscopic representations after the project-based acid-base experiment both in the experimental and control class.

<table>
<thead>
<tr>
<th>Num</th>
<th>Concept Label</th>
<th>Pre</th>
<th>Post</th>
<th>N-gain</th>
<th>Pre</th>
<th>Post</th>
<th>N-gain</th>
</tr>
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<tr>
<td>1</td>
<td>Arrhenius acid base theory</td>
<td>47.0</td>
<td>99.7</td>
<td>99.5</td>
<td>30.0</td>
<td>83.9</td>
<td>80.0</td>
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<td>Bronsted-Lowry acid base theory</td>
<td>17.4</td>
<td>91.0</td>
<td>93.2</td>
<td>25.5</td>
<td>82.3</td>
<td>78.5</td>
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<tr>
<td></td>
<td>Lewis acid base theory</td>
<td>28.7</td>
<td>92.3</td>
<td>93.9</td>
<td>26.8</td>
<td>82.6</td>
<td>79.4</td>
</tr>
<tr>
<td></td>
<td>Acid base properties</td>
<td>44.2</td>
<td>94.5</td>
<td>90.6</td>
<td>54.8</td>
<td>89.5</td>
<td>74.6</td>
</tr>
<tr>
<td></td>
<td>Acid base ionization degree</td>
<td>27.3</td>
<td>85.7</td>
<td>81.1</td>
<td>36.8</td>
<td>78.1</td>
<td>66.8</td>
</tr>
<tr>
<td></td>
<td>Acid Base Acidity Degree (pH)</td>
<td>16.7</td>
<td>68.7</td>
<td>63.0</td>
<td>31.9</td>
<td>59.4</td>
<td>30.7</td>
</tr>
<tr>
<td></td>
<td>Acid base</td>
<td>11.6</td>
<td>79.4</td>
<td>80.3</td>
<td>25.8</td>
<td>73.5</td>
<td>67.3</td>
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Presentation in Table 1 showed that the experimental and control class increase in the average value% N-gain (X~% N-gain) was highest in symbolic representation, while the lowest in the submicroscopic representation. Nevertheless, advanced statistical test was needed to see the difference between each representation. Statistical test on every level of representation is shown in Table 2.

Table 1. N-gain Percentage Statistic Test on Multiple Representation Indicator

<table>
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<tr>
<th>Num</th>
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<th>p</th>
<th>Sign</th>
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<tr>
<td>1</td>
<td>Simbolic</td>
<td>-0.384</td>
<td>0.701</td>
<td>Not significant</td>
</tr>
<tr>
<td>2</td>
<td>Simbolic</td>
<td>0.119</td>
<td>0.906</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Submicroscopic</td>
<td>-0.074</td>
<td>0.941</td>
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Based on the presentation of Table 4.10, there are several things that can be summed up as follows: (1) symbolic level with average value% N-gain (X~N-gain) 75.1 did not differ significantly with submicroscopic (74.2) and macroscopic level (74.5); (2) submicroscopic level with an average value % N-gain (X~N-gain) 74.2 did not differ significantly with symbolic (75.1) and macroscopic level (74.5); (3) macroscopic level with an average value% N-gain (X~N-gain) 74.5 did not differ significantly with submicroscopic (74.2) and symbolic (75.1) levels.

**DISCUSSION**

In general, it showed that the increase of N-gain multiple representations in experimental class better than the control class. This was because the project-based acid-base experiment used in the experimental class requires students to develop the ability of multiple representations. For example, when students analyzed the acid base compounds.
Students were required to provide or include multiple representations of pharmaceutical preparations either it is macroscopic, submicroscopic or symbolic levels. The tasks seem made students in the experimental class to develop their ability of multiple representations. Project-based acid-base experiments trained students to imagine and visualize any concept they learned. Model of representation at this level expressed range from the simple form to computer technology based, in the form of diagrams / drawings, and two or three-dimensional models. This finding was consistent that learning to integrate the visualization of molecular-based computer animation and simulation help students improved their ability to integrate three levels of representation and chemistry representation for better understanding [4].

Results of hypothesis testing between each multiple representations levels in experimental class showed that there was no significant difference, both at macroscopic, symbolic and submicroscopic level and symbolic versus submicroscopic level. Thus, there was no dominant indicator developed in the project-based acid-base experiment. This is evident from the average value % N-gain indicators macroscopic, symbolic and submicroscopic respectively are 74.5, 75.1 and 74.2. It showed that this research were able to develop multiple representation capabilities comprehensively at all levels of representation. This is evident from the % N-gain average value category is in a high category. Of course, in the laboratory experiment process, students’ macroscopic ability will be developed because the students are facing real compounds that can be recognized by the senses. However, sensing process was always followed by the process of completing the symbolic and submicroscopic representation on student worksheets, so the development of students' macroscopic ability always followed by the development of symbolic and submicroscopic representation capability despite the fact that students had some difficulty in developing their submicroscopic ability. Findings in macroscopic, symbolic and submicroscopic ability through project-based acid-base experiments was consistent with another study states that the model of project-based learning and multiple representations can help students improve the ability of multiple representation [1].

CONCLUSIONS AND SUGGESTIONS

Conclusions

Based on the data analysis, we concluded that the project-based acid-base experiment can develop all students’ multiple representations abilities in high category, the macroscopic representation (X̅, N-gain = 74.5%), submicroscopic (X̅, N-gain = 75.1%) and symbolic (X̅, N-gain = 74.2%) completely.

Students gave a positive response to the project-based acid-base experiment because it can increase students’ multiple representation ability. Teachers also gave a positive response to the model of learning because it provides clarity of purpose and the language used, the availability of learning tools that support and provide positive influence on the improvement of multiple representations ability.

Suggestions

In the implementation of project-based acid-base experiment models suggested that the buffer solution concept label (X̅, N-gain = 48.5) was significantly different with other concepts label except with the hydrolysis concept label and acid-base acidity degree (pH), therefore it was necessary to carry out in further research.
REFERENCES


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DEVELOPMENT OF STUDENT WORKSHEET BASED ON SOMATIC, AUDITORY, VISUAL, AND INTELLECTUAL (SAVI) IN REACTION RATE FOR SENIOR HIGH SCHOOL

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INTRODUCTION

Education is a major component of a nation’s progress. The success of the development of a nation in the future can be seen from how education is capable of forming qualified human resources. The curriculum is the heart of education, for the future curriculum should be designed and refined to improve the quality of national education and improve the quality of Indonesian human resources. In developing the 2013 curriculum emphasizes learning with the aim of learning processes towards basic competencies that lead to the mastery of life skills (life skills) that includes soft skills and hard skills which are needed in public life. Competence of graduates is expected with the development of curriculum is a balance between soft skills and hard skills that include aspects of competence attitudes, skills, and knowledge.

Problems in the learning process today is not solely due to the difficult material, but due to the way in delivering teaching material that is difficult to accept students or in other words the imprecision in the use of models and tools of learning and learning strategies. So that teachers are required more creative, innovative, do not feel as a teacher center, put the students not only as an object of study, but also as a subject of study and ultimately lead to the learning process fun, democratic and respect every opinion (Hanafi, 2009).

Chemistry as one of the subjects of science, the need to be able to explain various phenomena of chemical processes that occur in everyday life. Chemistry as part of natural science is always associated with the natural way of finding out about systematically, so that the chemical is not only mastery of knowledge in the form of a collection of facts, concepts, or principles, but also a process of discovery. One of the subject matter is the subject matter of the chemical reaction rate. Learning in the subject matter involves
reaction rate calculations and concepts. These characteristics give an idea that students should really concentrate on learning the material. And so we need to explain the methods and media. Therefore, the media used should conform to the learning style of the child, it would be more effective learning and child will be more enthusiastic in learning because the teacher explains the material according to the learning styles of students. Each child has a different ability to absorb the lessons of science. Learning styles of the children will determine how much a child of the material presented by the teacher. The similarity in the methods of delivery of material to the child's learning style would be to maximize the absorption and understanding of the child. Because they are not directly learning styles and learning styles of children's teachers will have the same pattern. According to Bobbi DePorter and Mike Hernacki learning style is a combination of how a person absorbs, and then organize and process information (DePorter, Bobbi & Hernacki, Mike: 2000: 110-112).

Learning style is not just a aspect when facing information, see, hear, write and speak but also aspects sekunsial information processing, analytical, global or left brain-right brain, another aspect is when responding to something on the learning environment (absorbed in the abstract and concrete). It really gives an indication of a very important and unavoidable for people learning style preferences, as well as their behavior and work style, and their natural strength. The types of intelligence that someone (Gardner shows most of us are strong in three types) not only showed the ability of people, but also the manner or method in which they prefer to learn and develop their strengths and also to develop their weaknesses. Gardner (in Uno, 2011: 76) explains that the children also learn well and understand what is learned when associated with what is already known and learning methods according to their learning style (style of learning to listen, look, and move or do) and various intelligence they possess such as language, music, movement, and personal. SAVI method (Somatic, Auditory, Visualitation, Intellectually) respect and understand each learning style which is owned by the students in a class. Then learning will be more effective because according to the learning style of every student. This is consistent with the results of Ery Wulandari (2013), stated that cooperative learning methods SAVI can improve student motivation and understanding of the concepts taught. SAVI method invites students to take advantage of all the senses are sight, hearing, movement, and mind. So that students not only be a good listener or passive, but they are invited to express their opinions and thoughts about the material being taught (Suprijono, 2009).

Activity of students in the class membrangaruhi maximize learning outcomes. This is consistent with the results of Ersanghou, et al (2008), that through the application of SAVI is expected to accommodate different student characteristics by using all the senses of the students. In the process of teaching and learning in the classroom is necessary teaching materials that help students absorb the information presented by the teacher. One of the teaching materials that can be used is the student worksheet (Mulyasa 2007 in Zanuarrita, 2010). Student Worksheet is sheets contains the tasks that must be done by learners (MONE, 2004). The sheets are usually in the form of instructions, the steps to complete tasks in the Student Worksheet must be clear and basic competencies to be achieved. Model Student Worksheet can be divided into two, namely: Student Worksheet observation and Student Worksheet experiments. Student Worksheet type of observation is not to manipulate variables but only describe the observations and summary. While on Student Worksheet experiments, in addition to conducting observations also perform manipulation of variables (Achmadi, 1996 in Zanuarrita, 2010). During this existing worksheets are less able to improve student learning outcomes, it proved difficult and lazy students in learning to use worksheets. That is because the student worksheets that there
are very monotonous in the making. Supposedly created worksheets that can accommodate all learning styles preferred by students. So that students will be happy to learn and more mature in understanding the concept of matter at student worksheet.

**METHOD**

The purpose of this research is to develop teaching materials that specifically untukLembar High School Chemistry Student Work SAVI based on rate reaction material. Thus this experiment is a research development develop SAVI-based Student Worksheet. In this study observed that include: feasibility Student Worksheet developed appropriateness criteria-based review of the student's learning style, in terms of the criteria of the material (contents, presentation and graph), linguistic, from teacher and student response assessment that includes aspects of the format and quality Sheet Students work presented. This means that this study is a descriptive study. This research was conducted in the classroom to help teachers facilitate a wide variety of learning styles are owned by their students in receiving material reaction rate through the Student Worksheet. Limited trial conducted on 19 students of class XI IPA. According Thiagarajan, Semmel, and Semmel (1974: 5) to design the development of teaching materials used system model 4-D approach (Four D Model). This model is composed of four stages: Define, Design, Develop, and Disseminate.

**RESULTS AND DISCUSSION**

From the research that has been done, the data obtained in the form of the review and validation worksheet SAVI were reviewed based on the criteria of content, presentation, linguistic, and graph, the results of student activity after using the Worksheet based on SAVI, and the students' response to the worksheet developed. To determine the feasibility of SAVI-based worksheet developed, it can be seen from the criteria of content, presentation, linguistic, and graph. To determine the feasibility of this worksheet, study conducted by experts in the field, a professor of chemistry and the chemistry teacher. In addition, the study also aims to obtain suggestions for improving worksheet. Student improvement suggestions based worksheet SAVI begin draft I to be the final draft, among others: the development STUDENT worksheet, need to be made more attractive layout and the use of language that is simple and easy to understand so much passion and motivated students to work on the worksheet STUDENT besides necessary selected in accordance with the preparation of the material each student's learning style. After the repair during the development stage, STUDENT worksheet then assessed by two validators that a chemistry teacher and a chemistry lecturer. Student activity observed during the learning process, which is assisted by 4 observers. In this lesson is divided into four major groups namely the somatic, audio, visual and intellectual. From each group formed observable activity each student every 5 minutes. To determine the activity of the students to use the worksheet based student SAVI. Questionnaire responses and students are given after the implementation of the test. Student questionnaire responses are used to study the response of students to use the worksheet based on SAVI Development of Student Worksheet SAVI-based refers to the model Four D (4-D) (Thiagarajan, Semmel, and Semmel (1974) in Novitasari, 2013). In this development only up to the third stage, which define (definition), design (design), and develop (development). In the development of this student worksheet implemented various stages of revision and study aims to improve their development of student worksheet that will be tried out to the students. feasibility of this worksheet is measured with several instruments, among other pieces of research and validation are used by experts in assessing worksheet developed, observation of student
activity sheets, and student questionnaire responses to determine the response of students to the worksheet developed.

**Eligibility Worksheet SAVI**

Student Worksheet is an important component to support students in learning activities based on SAVI because STUDENT worksheet that will lead students to learn these concepts according to the learning style of each student. Additionally, STUDENT this worksheet will be used as a benchmark in the student's ability to learn to use learning strategies SAVI, which consists of learning styles somatic, audio, visual and intellectual. In developing this worksheet STUDENT adapted to the learning style used is SAVI. Therefore, STUDENT useful worksheet to create opportunities to learn independently with the guidance of teachers, increase the level of students' understanding of the subject matter, and preferred learning activities of students (MONE, 2004).

Student worksheet developed consisting of a topic that is of factors on the rate of reaction, in which there are 4 sub kinds of materials, among others: the concentration factor, surface area, temperature and catalyst on the reaction rate. Criteria assessed on this worksheet should qualify that includes criteria for the content, presentation, linguistic, and graph. The average score for all aspects of the validation results obtained by 85% which means that the category of very decent. In the assessment criteria contents worksheet, two aspects of getting a good category and six aspects of getting a very good category. This is because student worksheet was developed in accordance with the curriculum in 2013 and the core competencies, basic competencies and learning outcomes indicators. In presenting the assessment worksheet two aspects to get a good category and three other aspects of the very good category. While the assessment of language, one aspect of the language gets a good category and four other aspects got very good either category. As well as on graph assessment, four aspects of graph got good category and three other aspects got very good either category. This is due to the development of this worksheet has been through a process of repeated revisions based on feedback from supervisors and senior high school chemistry teacher in Surabaya Widya Dharma. In every learning style assessment activities in student worksheet based on SAVI which is a very important point. It is greatly affected of all the contents of the worksheet developed. So in this worksheet there are four sections each learning style that is part somatic, audio, visual and intellectual.

**Student Activity**

Student activity were obtained by observation of the learning process using observations of student activity sheet instruments. This observation process carried out by four observers, which everyone watched one large group (somatic, audio, visual and intellectual). Thus, in this observation can process data related activity each student in the group learning. Giving this questionnaire aims to determine students' response to the student worksheet. The percentage of somatic greatest activity in each encounter with an average of 49%, 15% audio, visual 19%, and 15% intellectual. In the audio group, amounting to 5 people has a percentage of the greatest audio activity in each encounter with an average of 48%, 19% somatic, visual 17%, and 14% intellectual. In the visual group consists of 4 people has a percentage of the greatest visual activity in each encounter with an average of 47%, 17% somatic, audio 13%, and 22% intellectual. In the group of intellectuals who are 4 people have a percentage of the greatest intellectual activity in each encounter with an average of 46%, 20% somatic, audio 17%, and 17% visual. Each groups learning styles have percentage greatest activity according to their learning style. However, it is possible there are also other learning styles activities undertaken by students. Therefore, by using a worksheet SAVI can increase the activity of students in accordance with the interests of their own learning styles and can also train other learning styles.
Because aktivitas students will increase according to their learning styles and learning will be more interesting and fun (Meier, 2010)

**Student responses**

Student responses obtained by giving the questionnaire after the learning process is completed. Giving this questionnaire aims to determine students' response to the student worksheet. Based on the response data, this worksheet can help students learn the material factors on the reaction rate. In addition, previous students have never used a worksheet based on SAVI, so at the beginning of work on the worksheet individual students still feel unfamiliar with this model student worksheet. So for the first meeting of the first students to adapt to the worksheet. Then at a later stage, the working group student worksheet, students are used to using the worksheet based on SAVI.

In the clarity of criteria-based material on the worksheet SAVI, most aspects of a positive response from the students. As many as 97% of students stated this worksheet to facilitate the students to understand the material on this worksheet. In interest criteria students with the alkaline-based worksheet SAVI, most aspects of a positive response from the students as well. As many as 92% of students stated excited and interested in this worksheet in the learning process. In order to get a positive response from the students after using the worksheet based on SAVI. For high school students in Surabaya Widya Dharma, learning using learning styles has an interesting thing. Increased willingness of students to learn this in accordance with the purpose of teaching strategies that teach students to learn on his own (Nur, 2004). Additionally student worksheet that covers most of the concepts taught in the learning style of each student can maximize student understanding of the material being studied. Students feel happy because this worksheet can facilitate any of their learning style so that learning becomes fun and be active in student learning. (Meier, 2010).

**CONCLUSIONS**

Based on the research that has been done, it can be concluded some of the following:

1. Eligibility Worksheet developed in terms of the criteria of content, presentation, linguistic, and graph based assessment is expressed very strong validator (very decent) with the average percentage of the feasibility of 85%.
2. Student activities have the greatest presentase suit their learning style groups, namely the somatic (S: 49%), the audio group (A: 48%), visual group (V: 49%), and the intellectuals (I: 46%).
3. Student responses to the worksheet based STUDENT SAVI developed positively with percentage value ≥ 61% for all aspects.

**REFERENCES**


APPLYING THE “COGNITIVE CONFLICT” STRATEGY TO FACILITATE CHANGES IN THE CONCEPTION OF FIRST SEMESTER STUDENTS ON THE TOPIC OF VOLTAIC CELL

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### Article info

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### Abstract

The main objective of this study was to obtain the information regarding freshman students’ alternative conceptions, the characteristics of conflict cognitive strategy and the profile of students’ conceptual change in Voltaic Cell, which were further elaborated into six determined indicators. The subject consisted of fourteen freshman students of Chemistry Programme. This study was conducted into three stages, which were (1) pre-test, (2) cognitive conflict instruction and (3) post-test. Students’ conceptions profile were classified into three categories based on Appleton, 1999 (Rolka, 2007), which were identical fit, approximate fit and incomplete fit. Based on the data obtained from the pretest, students generally performed the incomplete fit and approximate fit for all indicators, but only a few performed the identical fit. The characteristics of conflict cognitive strategy that is able to facilitate students’ conceptual change was those that destabilize students’ inaccurate existing conception through contradictory experiences (disequilibrium), followed by teacher’s intervention that enables the students rich the reequilibrium. After the instruction, students generally performed the raising conception profile, but some did not perform conceptual change and only a few performed the lowering one.

### INTRODUCTION

In general, students learning in the classroom are not in a blank state. Instead, they have brought a number of experiences and ideas that are formed from previous interactions with the environment (Pinker, 2003). Duit (2002) says that the initial conception of the students is not generally accepted in accordance with the concept of the experts. Kutluay (2005) says that conception is incompatible with the conception of which scientists called as alternative conceptions. According Driver (Khurshid, 2009), it can be sourced from alternative conceptions of learning in school, out of school learning, everyday experiences, social environment, and intuition.

Based on the experience of a lecturer in Basic Chemical class, the findings obtained alternative conceptions of first semester students on the topic of Volta cells. This topic is the first topic they learned in the course Basic Chemistry II. The first semester students...
have studied topics of Volta cells in high school. However, some research suggests the findings related to alternative conceptions on this topic. Sanger and Greenbowe (1999) conducted an analysis of several chemistry textbooks as the sources of the emergence of alternative conceptions and learning difficulties in electrochemical materials. Ozkaya et al (2003) found that teachers also have alternative conceptions regarding electrochemical materials. Dindar et al (2010) also found alternative conceptions of teachers on the topic Volta cells, namely the salt bridge subtopics.

Klammer (1998) states that alternative conception is very resistant to change (Kutluay, 2005). If the alternative conceptions have been entered into the cognitive structure of students, then the alternative conception will hinder the process of acceptance and assimilation of new knowledge that would hinder the success of students in the further learning process (Toka and Askar, 2002). Therefore, we need learning conditions that can change the alternative conceptions into scientific conception through learning to be more necessary, intelligible, plausible, and fruitful (Posner, 1982).

According to Piaget (Hergenhahn and Olson, 2009), humans have an internal need to be in a state of balance between understanding the cognitive experience. When individuals experience imbalance (disequilibrium) between perception and experience, this situation motivates individuals to solve the conflict. Piaget called the process of solving this conflict as re-equilibrium, which is defined as the process of setting the self (self-regulation) in response to stimuli from the environment and adjust to the new experiences that fit into existing cognitive structures (assimilation) and structural improvements for the adjustment of new data (accommodation).

As previously stated by Posner and Piaget, one of the learning strategies that can be used to facilitate change students' conceptions of alternative conceptions towards a scientific conception is cognitive conflict. Johnson and Johnson (Lee, 2003) suggests that this learning is conditioned by presenting different views or disagreement between students and students or between teachers and students to develop a deeper knowledge. Lee (2001) says that a cognitive conflict is not only characterized by feeling of doubt, dissatisfied, wonder, and interested or agitated, but can also result in destructive if students are frustrated.

Rolka (2007) describes and analyzes the students' conceptions profiles submitted by Appleton (1997) during the learning of science. This conception profile model in accordance with the terms of assimilation and accommodation Piaget and analyze the possibility that occurs when students meet the new information and experiences. When this information is processed, the development of conflict situations can be described into three possibilities as follows:

1. **Identical fit**
   The new information received in complete agreement with prior knowledge that has been owned. Students are able to understand the new information with prior knowledge base they have. However, this does not mean that the explanation given by the students are correctly complete.

2. **Approximate fit**
   The new information received by the students associated with prior knowledge they have, but the details of the new knowledge is not clearly linked. The students acquire new ideas, but still engage old ideas that have been previously acquired. Although contradictory, the students do not achieve cognitive conflict situations. Therefore, the new information is assimilated but not accommodated in students' thinking.

3. **Incomplete fit**
   The stated new information does not match the students with the expected thought. This information which does not match generates cognitive conflict. When students
experience a state of incomplete fit, they tried to reduce conflict by seeking information that may be used as a solution.

**METHOD**

This study uses a pre-experiment one group pre-test post-test design. 14 first semester students were given the initial ability test to obtain early conception student profile data. The initial conception of student profiles is taken into consideration in formulating Learning Implementation Plan (RPP). Treatment of cognitive conflict strategies is made using practical methods, expository, and discussion. Then, the students were given the final ability test to obtain the end of the conception of the student profile data after being treated. Furthermore, an analysis of changes in the conception of student profiles is conducted.

Test instruments are developed in the form of a structured essay test consisting six items in which each questions are used to evaluate each of the indicators developed. The validation of test instruments is performed by three lecturer experting on electrochemical topics and one lecturer experting on evaluation. The results of trial tests using the formula Alpha provides reliability value of 0.88 with interpretation about reliability to be very high.

**RESULTS AND DISCUSSION**

Based on the initial test results and test the ability of end capabilities, overall there is no student who had no conception at all (no conception) because they have studied the topic Volta cells while still in high school. Interviews showed that prior to the initial ability test, the students not only learn topics Volta cells in high school, but they also taught themself by reading books and enrichment articles, encyclopedias, science magazines, and discussions with their peers. Therefore, in this study the students has brought a number of conceptions on the topic Volta cells based on their experiences while studying in high school and supplemented by self-taught learning.

There are 6 indicators developed in this study, namely:

1. Determining the spontaneity of oxidation-reduction reaction by Volta series.
2. Determining spontaneous oxidation-reduction reaction that can be used to generate electric current.
3. Determining the circuit which can produce oxidation - spontaneous reduction to generate electric current.
5. Distinguishing oxidation - spontaneous reduction in the circuit without salt bridge Volta cells and cell Volta with salt bridge.
6. Identifying positive and negative poles of Volta cells based on the direction of the flow of electrons that occurs.

**Students Conception Profile on Initial Ability Test**

Based on Figure 1, it is known that generally the students are in the category of incomplete and approximate fit. There are only a small proportion of students who are in the category of identical fit.
Treatment Of Learning

In general, treatment of learning follows the path shown in Figure 2. The given treatment uses practical methods, expository, and discussion. By the time the lab, not done weighing the mass of electrodes, but only based on changes that can be observed directly by the students. Students were divided into seven groups, each group consisting of two people. The division of the group announced at the initial ability based on their scores on the initial test of Basic Chemistry 2, which includes high school material on thermochemical, kinetics, chemical equilibrium, and electrochemistry. Therefore, each group can be assumed to have almost the same distribution capabilities. Each student is given an MFI which contains guidelines experiment to answer the problem (questions) on the initial ability test and the end ability test.

Figure 1. Students Conception Profile on Initial Ability Test

1. Treatment in Indicator 1

Students perform four experiments are shown in Figure 3. In systems 1 and 3, the blue color fades CuSO4 solution and on the surface of Zn precipitation is originally black, but later became a reddish brown.
Some students initially assume that the black color is because they never saw CuO black when in high school. One of the students said that the CuO formed from the reduction of Cu $^{2+}$ into Cu, Cu then react with O2 in the air. Researchers showed that Cu is left for more than three hours in the open air did not give a black color, which means that the reaction of Cu with less oxygen in the air does not happen quickly. Some students become hesitant with their initial answers. Lee (2001) said that doubts about their own answers are characteristic that they experience cognitive conflict situations. Then, researchers intervened in the form of questions given by mentor until they conclude that the precipitate formation on metal surfaces Zn Cu occurs gradually in which its previous color were black that marks the beginning of this precipitate absorbs energy at all wavelengths of visible light. When the Cu precipitate formed already started excessive, then there is a certain amount of energy after the energy emitted at all wavelengths are absorbed. The energy emitted is in the brownish-red color wavelength (480-500 nm).

2. Treatment of the indicators 2 and 3

Students conduct experiments shown in Figures 4 and 5. In the system 5, Zn and Cu electrode is dipped into a solution of 0.1 M CuSO4 Both electrodes are in the same container and connected by an external circuit and multi-meter.

System 5 generates a potential difference measured in multi-meter, the blue color fades CuSO4 solution, and the reddish-brown precipitate is formed on the surface of the electrode Cu and Zn.

Figure 4. System 5
Some students revealed the expression of interest and anxiety because of the results of their experiments are in contrast to the theory they learned from high school books. This interest and anxiety situations, according to Lee (2001) is a hallmark of cognitive conflict. Most of the students argue there should be no electric current occurs so the multi-meter needle should not move because in the system 5 the whole the ejected electrons from the oxidation reaction of Zn was used to reduce the surface Zn Cu2+. Most of the other students found no electric current that is generated, but only for a moment so that the multimeter needle should immediately return to zero. Those, who argue that there is momentary electric current that is generated, say that the electrolyte solution in system 5 experiences the non-neutrality charge. There also were found metal Zn coated with Cu that cannot oxidize again. Another student is not certain toward the identity of the anode and cathode in this circuit and could not explain why the zinc which is apparently anode also be a reduction reaction.

Researchers guide students through the questions until they conclude that the electrons that are released on the system 5 can experience two things, namely:

1. Electron of Zn oxidation products flows through the outer circuit toward Cu due to the potential difference between Zn and Cu. Electrons flow through an external circuit to generate electric current. Because the electrons flow toward Cu, the Cu2+ around the surface of the Cu captures electrons and form deposits on the surface of Cu.

2. There are also electrons which could not flow through an external circuit due to direct electrons captured by Cu2+ ions are located around the surface of Zn. As a result, the reduction of Cu2+ can also occur on the surface of Zn.

With the guidance of researchers through the questions, the students concluded that in the system 5 the non-neutrality charge does not occur because each Zn2+ that is formed is always followed by the reduced Cu2+.

Researchers say that the electrolyte solution used in this experiment has a low concentration (0.1 M), ten times more dilute than the standard state (1 M). With the questions of supervisor of researchers, students concluded that the more concentrated electrolyte solution concentration, the oxidation - reduction is faster and Zn surface quickly covered by Cu sediment so Zn can not undergo further oxidation reaction. However, in the lower electrolyte solution concentration, the surface of Zn did not immediately covered by Cu sediment so that the electric current produced can last longer.

Furthermore, in the system 6, Zn and Cu electrode is dipped into a solution of 0.1 M ZnSO4 Both electrodes are in the same container and connected by an external circuit and multimeter.

System 6 generates a potential difference measured in multimeter and bubbles formed around the surface of the electrode Zn and Cu.

Most of the students become uncertain to the theory which they have learned and others doubt the outcome of their trial. According to them, should the system 6 can not produce oxidation - spontaneous reduction.
Researchers guide students through the questions until they conclude that Zn2+ ions in the water undergoes partial hydrolysis reactions produce ion H3O+

\[
\text{ZnSO}_4(\text{s}) \xrightarrow{\text{H}_2\text{O}(\text{l})} \text{Zn}^2+(\text{aq}) + \text{SO}_4^{2-}(\text{aq})
\]

Zn2+ ions in water are the most stable in the form of complex \([\text{Zn(H}_2\text{O})_6]^2+\).

\[
[\text{Zn(H}_2\text{O})_6]^2+(\text{aq}) + \text{H}_2\text{O}(\text{l}) \quad \leftrightarrow \quad [\text{Zn(H}_2\text{O})_5\text{OH}]^+(\text{aq}) + \text{H}_3\text{O}^+(\text{aq})
\]

With the hydrolysis reaction to this, the number of ion H3O+ or H+ which is in solution becomes more and more because of H+ is now not only generated from ionization reaction of water, but also from the hydrolysis reaction. This is evident from the blue litmus paper turns red when it is dipped into a solution of ZnSO4.

With questions supervisor of researchers, students concluded that based on the series Volta, metal Zn and H+ ions can undergo oxidation reaction - spontaneous reduction as follows:

\[
\begin{align*}
\text{Zn(s)} & \rightarrow \text{Zn}^2+(\text{aq}) + 2\text{e}^- \\
2\text{H}^+(\text{aq}) + 2\text{e}^- & \rightarrow \text{H}_2(\text{g}) \\
\text{Zn(s)} + 2\text{H}^+(\text{aq}) & \rightarrow \text{Zn}^2+(\text{aq}) + \text{H}_2(\text{g})
\end{align*}
\]

With the supervisor questions regarding the movement of electrons and concentration as in 5 above system, students can infer why the system 6 can generate electric currents and bubbles are formed around the surface of the metal Zn and Cu.

On these indicator 2 and 3, there are a small portion of students who are aware of the situation of cognitive conflict, but are not interested in resolving the conflict because they think this matter is too confusing. This is consistent with the findings of Lee (2001) that cognitive conflict can be destructive if students feel frustrated. Therefore, teacher intervention is indispensable not only to make students aware of the situation of cognitive conflict, but also to enable students to resolve conflicts (re-equilibrium).

3. Treatment of Indicators 4

Students conduct experiments 5 and 7. At system 7, Zn electrode is dipped into a solution of 0.1 M ZnSO4 and Cu electrode is dipped into a solution of 0.1 M CuSO4 in two different containers. Both electrodes are connected by an external circuit and multimeter.

No potential difference is measured in multimeter. However, the Cu electrode looks a bit more polished.

Through mentors of researchers questions, students concluded that the system 7 only generates electrical current moment due to the non-neutrality of the charge - electrolyte
solution in the cell anode excess positive charge (Zn²⁺) due to oxidation of zinc and electrolyte solution at the cathode excess negative charge (SO₄²⁻) due to the reduction of Cu²⁺.

There was one student who doubt the circuit which one is better to be used as a cell Volta between system 5 and 7 because he thinks Volta cell with an anode and a cathode in two separate containers is better than that only in one container. Another student said that system 7 exists to address the shortcomings of system 5, namely that Cu deposit formation only occurs at the cathode, but the concentration of the aqueous electrolyte solution, the system 5 generates a longer electric current, whereas system 7 only generates electrical current in a moment since the system 7 experienced partiality charge on the electrolyte solution, while the electrolyte solution in system 5 remains neutral. This shows that at this stage, fellow students were able to provide interventions to achieve a balance of cognitive (re-equilibrium).

4. Treatment on Indicators 5

Students conduct experiments 7 and 8. In the experiment 8, Zn electrode is dipped into a solution of 0.1 M ZnSO₄ and Cu electrode is dipped into a solution of 0.1 M CuSO₄ in two different containers. Both electrodes are connected by an external circuit and multimeter. In between the electrolyte solution is applied salt bridge.

![Figure 7. Experiment 8](image_url)

The blue color of CuSO₄ solution is faded, metallic colored Cu is increasingly shiny, and the potential difference in the multimeter measured continuously.

With the guidance of researchers through the questions, the students concluded that the negative ions of the salt bridge moves into the cell anode with excessive positive charge, while the positive ions of the salt bridge moves into the cell cathodes with excessive negative charge due to the higher concentration of the electrolyte solution in the salt bridge than the concentration electrolyte solution in both cell anode and cathode cells.

Some students argues that excessive Zn²⁺ ions at the anode cells cannot move to the cathode cell with excessive negative charge on cathode cell and excessive SO₄²⁻ ions in cathode cell can not move to the anode cells that with excessive positive charge, while others said that such movement of ions possibly happen.

With the guidance of researchers through animated show, the students concluded that the function of the salt bridge is to facilitate the movement of ionic to make charge neutrality occurs in both cells. The most dominant mechanism of ion movement is the salt bridge towards the anode and cathode cells because the concentration of the electrolyte solution in the salt bridge is higher (saturated solution) compared to the concentration of...
the electrolyte solution in the cell anode and cathode. However, the movement of Zn2+ ions from anode cell to cathode cell or SO42- ion movement from the cathode to the anode cells may also occur.

In this indicator, students generally do not experience cognitive conflict situations because the observation results do not contradict the theory they have learned. All students have understood since high school that the second electrode Volta cells are separated and applied salt bridge is a series of best Volta cells.

5. Treatment at Indicator 6

Students conduct experiments 9. The series of trials is the same as the test series 8, but with the positive pole multimeter connected with the anode and the negative pole to the cathode connected multimeter.

Some students wonder why the needle multimeter on moving to the left, not the right. This astonishment is one of the characteristics of cognitive conflict situations according to Lee (2001).

Researchers guide students conclude this phenomenon. If the anode is connected to the positive pole of a multimeter and a cathode connected to the negative pole multimeter (system 9), then the multimeter needle deviated to the left. However, if the anode is connected to the negative pole multimeter and a cathode connected to the positive pole multimeter (system 8), then the needle multimeter turns to the right. Based on this phenomenon, the students concluded that the anode in Volta cell is a negative pole, while the cathode is the positive pole.

Based on the questions of investigators’ supervisor about the direction of the electrons in the Volta cell and physics convention regarding the direction of the flow of electrons, the students concluded that the anode in Volta cell is a negative pole, while the cathode in Volta cells is the positive pole and this can be proved through experiments.

6. Students Conception Profile on End Ability Test

Based on the figure 8, usually students are in the category of identical fit and approximate fit. Only a small proportion of students who are in the category of incomplete fit.
Based on Table 1, it can be seen that generally students who are in the category of incomplete fit are more easily to change conception compared with students who are in the category of approximate fit. This is consistent with the statement of Appleton (1999) in Rolka (2007) that students who are in the category of approximate fit obtain new ideas, but still engage old ideas that have been previously acquired.

![Figure 8. Students Conception Profile on End Ability Test 7. Change of Student Conception Profile Before and After Treatment](image)

**Table 1. Change of Student Conception Profile**

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In the initial ability test, generally students are in the state of incomplete fit and approximate fit to all indicators. Only few of students who are in the state of identical fit.

1. The characteristic of cognitive conflict learning which can facilitate the change of student conception is a learning conditioning students to find imbalance between their prior knowledge with the acquired fact experiment, followed by teacher’s intervention to enable the conflict situation result a new balance.

2. After acquiring the strategy learning of conflict cognitive, generally students increase their conception profile. However, there are some others who gain no change, even decreasing conception profile.

**SUGGESTION**

For the development of cognitive conflict further research, the authors propose the following suggestions:

1. Need to develop design conflict strategies that can facilitate cognitive conflict conception changes, especially on topics of chemistry that are sensitive to alternative
conception based on issue that arise in the field, the character of the material, and relevant learning theory.

2. Need to develop an evaluation tool which can measure the alternative conceptions, especially on topics of chemistry that are sensitive to alternative conception.

REFERENCES


WHAT’S THE MAIN DIFFICULTY OF CHEMICAL-EQUILIBRIUM TOPIC?

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Abstract

Chemical equilibrium is one of chemistry topics that sometimes reputed as difficult topic by the students. This study is a descriptive research which aimed to find out the difficulty of eleventh grader students to solve the chemical equilibrium questions. The sampels in this research were thirty two students in one class that choosed by simple randomize sampling. The data was collected by instrument which has 7 items in essay test and also questionnaire. The data was analyzed by descriptive statistic method to obtain percentage of the difficulty in each factors. There are four main factors have been analized: understanding the definition and basic concept of equilibrium, calculation of chemical equilibrium, predicting the direction of equilibrium, and basic supporting skills. Inside this main factors there are 12 indicators of difficulty. The result of this research showed that average percentage of difficulty of students to learning of chemical equilibrium categorized as low category. Through these 12 indicators, the most influence factor to the difficulties of chemical equilibrium is determine of dissociation degree and equilibrium constant. It is suggested that instructions and topics which students will learn should be focusing on dissociation degree and equilibrium constant matter.

INTRODUCTION

Education is one of the factors that determine the success of a country. Therefore, change and improve the quality of education require attention from various parties, in this case the government and all experts, observers to education practitioners. Various devices are expected to support education, wherever possible change according to needs, including curriculum. This has been seen with the curriculum changes, namely the alternation of the curriculum from time to time.

The curriculum goal is to create a quality of Indonesian human. Human qualities needed by Indonesia in the future is able to face increasing competition with other nations in the world. In 2013 the Human Development Index (Human Development Index) issued by UNDP, Indonesia only ranks 124 of 187 countries. Among the countries of Southeast Asia, Indonesia is still less than those in Singapore who are on rank 26, Brunei (33), Malaysia (61), Thailand (103) and the Philippines (112). However, HDI Indonesia is still better than Vietnam (128) and Laos (137) (hdr.undp.org).

Related to efforts to improve the quality of education, educators or teachers are required to constantly improve themselves both in knowledge of the field of study as well as the management of the learning process. This is so that students can learn each subject properly so that they are able to follow the development of science and technology, and can apply it in everyday life.
Chemistry which for some people is difficult subjects and requires extra thought to be able to understand the dam studied. So schools often we find students who have difficulty in learning chemistry. Especially for high school students were charged with a number of subjects who faced relentless weekly basis. The difficulty is what needs to be identified so that educators can find teaching methods or the appropriate solution in the teaching of chemistry.

The diversity of students' intellectual abilities, especially in chemistry in high school so varied. This capability involves the ability to: recall, understand, interpret information, to understand the meaning of symbols and manipulate them, abstracting, generalizing, reasoning, problem solving, and much more. Attitude and temperament also diverse, both in response to learning in general and chemistry in particular, as well as interest and emotions. Various matters relating to students was also developing joint learning environments, both directly impacting students or indirectly. Methodology and all aspects of learning created by teachers, teaching topic, learning resources, media, and the classroom situation also helped provide impetus and obstacles in students' learning.

Chemistry teacher who complained about the lack of ability of many students in working on chemistry. This is evident from the many mistakes the students in working on the problems, resulting in low student achievement in both the daily test, repeat the semester and final exams nationwide despite the problems that arise when the test shape is almost the same (slightly different) with ples sample questions provided by the teacher during the learning process in the classroom as well as the tasks given continuously with diverse exercises. However, in reality this does not fully exercise can boost students' skills in solving chemical problems.

Encouragement of teachers to solve the problem of student difficulties is one element in the development of the teaching profession. It is grounded in the principles of diagnosis in the context of problem solving. In this context we refer to life skills: the problem is something that must be found in life that have to be solved rather than avoided, because the escape on the side will appear again the same or similar problems, also allows adding a lot more difficult problem to solve. The difficulties faced by these students need to be found and ascertained the source, handle, with the hope of solving the problem. Teachers will act as a doctor who must diagnose 'disease' or source 'disease' students, to then prescribe treatment.

Chemical equilibrium subject matter taught in eleventh grader class is topic in chemistry is quite complex and complicated. This topic contains the main points of the topics that are interrelated to one another, so that students who do not understand the previous material, especially topic reaction rate will have difficulty in studying the next material. This topic also requires an understanding of definitions and concepts, training, basic numeracy skills and abilities. So it can be assumed together with that chemical equilibrium deserves the title as one of the materials that make it difficult for students.

Definition of learning difficulties was first proposed by the United States Office of Education, known as Public Law (PL) as follows: "The difficulty of learning is a disorder in one or more of the basic psychological processes that include the teaching of language comprehension or writing. The disorder may manifest themselves in the form of hard of hearing, thinking, talking, reading, writing, spelling and arithmetic ". Another definition, Ahmadi and Supriyono in his book Psychology of Learning states that learning disabilities is a condition in which the student or students can not learn properly.

Several other definitions of learning disability include:

1. The National Joint Committee for Learning Disability (NJCLD) defines learning disabilities refers to a group of difficulty is manifested in the form of learning difficulties are apparent in the acquisition and use of the ability of listening, talking,
reading, writing, reasoning or numeracy

2. The Board of the Association for Children and Adulth with Learning Disability (ACALD) defines learning difficulties a chronic condition that allegedly sourced neurological selectively interfere with the development, integration, and or verbal and non-verbal.

Based on the definition that has been said Mulyono concluded that all three have points in common, namely (1) the possibility of neurological dysfunction, (2) the difficulty in academic tasks, (3) the gap between the achievement potential, and (4) the expenditures of other causes.

The description above can be concluded that learning disabilities is a condition of learning disorder characterized certain obstacles that interfere with the learning process.

Chemistry is the science that many concerned in understanding the essential nature of the substance. Discuss chemical system that includes complex, ranging from the atom molecules and compounds. Based on the description, it can be said that the goal of the discussion focused on the chemical sciences to understand the properties of matter and its changes. Chemistry is a science that is acquired and developed based on experiments that seek answers to the questions of what, why, and how the natural phenomena, especially with regard to the composition, structure and properties of transformation, dynamics and energetics substances.

Learn the concepts of chemistry, the most important thing to note is how the students develop their understanding of these concepts as well as the possibility to implement it. The existence of errors in understanding the concepts can result in students failing to learn the concepts, as well as less successful in applying the relevant concepts to new situations and relevant.

There are quite a lot of chemistry concepts such as a material change, moles, chemical bonds, the rate of reaction, carbon compounds, acids and bases, solubility dn solubility product and others. Generally the law and taught abstract notion that require logical thinking skills, continuous learning system as well as the delivery of content in a systematic way.

Studied chemistry, in addition demanded the ability to memorize and understand the basic concepts are also needed basic math skills and the ability to analyze the relationships between concepts in the material. Basic math skills are required, namely the operation of multiplication, division and multiplication exponential number. For that in studying chemistry must also be followed by exercises solve the problems of chemistry.

METHOD

This study was a descriptive research. This research conducted to find out the difficulties of eleventh grader students to solve the chemical equilibrium questions. Below is a framework of this research, composed by the author that contains four main difficulties which are divided into twelve indicator of difficulties.

<table>
<thead>
<tr>
<th>TABLE 1. Factors and Indicators of Difficulties</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.</td>
</tr>
<tr>
<td>-----</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
</tbody>
</table>
The participant of this study was the student in a formal senior high school in a recency in Indonesia. There are 4 class of eleventh grader in this school. Sample of the class was choosed by Simple Random Sampling. It is 32 students in the choosen class. This method is using by assume that all of the elevent grader of this school was homogenous and there are not classification by studies achievement.

The tecnics of collecting data was from the score that students achieved. There are two instruments ie Study Achievement Test and Questionnaire. Study Achievement Test consist of 7 number that based on Chemistry Syllaby of Indonesian Curricula. This test’s aim is to find out the difficulties of the student solve the chemical equilibrium problem. Each wrong answers assume as a difficulty. Second instruments was questionnaire that consist of 12 problems that represent the difficulties’ indicators by Likert scale. Starts from Extremely Agree, Agree, Doubt, Disagree, Extremely Disagree. As the result, The difficulties will be categorized as five category ie. low, very low, medium, high, very high.

Data collected and analyzed by Linear Regresion Model by using SPSS program. We assume that all the 12 indicators influence partially to the difficulties of chemical equilibrium. The value of effect measure by the value of Standardized Coefficients and value of t. The value of Standardized Coefficients shows how much the effect of each indicators as independent variabel to the chemical equilibrium difficulties which is the dependent variable. The combinations effect of 12 indicators also can be measure by the value of R square and Determinations Coefficient.

\[ DC = r^2 \times 100\% \]

RESULTS AND DISCUSSION

Below are the result of Study Achievement Test that showing how many students got difficulties in chemical equilibrium and their category.

<p>| TABLE 2. Factors of Difficulties of Students to Solve The Chemical Equilibrium Problems |
|---------------------------------|-----------------|-----------------|</p>
<table>
<thead>
<tr>
<th>No.</th>
<th>Factors of Difficulties</th>
<th>Percentage of Difficulties (%)</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Comprehension of Definition and basic concept of chemical equilibrium</td>
<td>22.72</td>
<td>Low</td>
</tr>
<tr>
<td>2</td>
<td>Calculations of Chemical Equilibrium</td>
<td>16.86</td>
<td>Very Low</td>
</tr>
<tr>
<td>3</td>
<td>Determination of Chemical Equilibrium</td>
<td>30.21</td>
<td>Low</td>
</tr>
</tbody>
</table>
The questionnaire in this study analyzed by SPSS using Linearity Regression Model to measure the effect of difficulties factors of study, both in partially and combinationally. **TABLE 3.** Table of Coefficient Indicators Difficulties to the Chemical Equilibrium

<table>
<thead>
<tr>
<th>No.</th>
<th>Factors of Difficulties</th>
<th>Percentage of Difficulties (%)</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Basic Supporting Skills Average</td>
<td>29.58</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td>24.84</td>
<td>Low</td>
</tr>
</tbody>
</table>

According to the tables above, we can conclude that Chemical Equilibrium topic was not extremely as a difficult topics in chemistry. All the category shows as low levels. According to Table 3 we can see that the most influenced indicators was determine the dissociation degree and equilibrium constants. It influenced significantly. All the 12 category combinationally make influenced to the chemical quilibrium difficulties that measure by R square and Determination Coefficient.

\[ CD = r^2 \times 100\% \]
\[ CD = 0.567 \times 100\% \]
\[ CD = 56.7\% \]

This number means that all the indicators influenced the difficulties as 56.7%. Moreover 43.3% (from 100%-56.7%) influenced by other factors that not included by this research.

This descriptive research contains many lack that should be completed by deep
interview to all student to know what the really difficulties that student get in their daily learning. Maybe factor that more influenced is not connected by the lesson, but the personality or internal factors of the students.

CONCLUSIONS

The result of this research showed that average percentage of difficulty of students to learning of chemical equilibrium categorized as low category. Through these 12 indicators, the most influence factor to the difficulties of chemical equilibrium is determine of dissociation degree and equilibrium constant. It is suggested that instructions and topics which students will learn should be focusing on dissociation degree and equilibrium constant matter.

REFERENCES

DEVELOPMENT OF STUDENT WORKSHEET BASED GUIDED INQUIRY ON ACID BASE TITRATION FOR CHEMISTRY LEARNING CLASS XI SENIOR HIGH SCHOOL

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INTRODUCTION

In the development of Science and Technology (Science and Technology), one or the other that important is the science of chemistry. Chemistry is a part of natural science that studies about the composition, properties and transformations of matter and how the composition of a material affects it’s properties [1].

Chemistry is a science that is also included in the group of natural science, whose development is based on the results of experiment to produce facts and theoretical knowledge. In studying chemistry students are not only required to learn more about the concepts and principles of science in verbalists, rote, the introduction of formulas, and the introduction of terms through a series of exercises verbally but also understanding and analysis of high.

One or the other of subjects studied chemistry class XI Senior High School is acid-base titration. Most students assume that the material is a material that is difficult to understand. This is caused by the chemical during the learning process is still oriented towards authorizing theory and rote learning ability, causing students to be less developed. Thus, it can be concluded that the students' learning chemistry is still not able to maximize...
their ability to learn on their own and the lack of involvement students in the learning process.

Demand in curriculum 2013 oriented to active students learning (students centered). Students are required to actively and independently in the learning process, while the teacher acts as a motivator and facilitator. A teaching work will well if a teacher can develop a state of the students to learn, so the learning experience students direct benefit to the development of them personality [2]

Therefore, a teacher needs to plan learning strategies that can enhance the student's active participation. One or the other strategy is suitable strategies of inquiry learning. Inquiry learning has four levels, namely the confirmation inquiry, structured inquiry, guided inquiry and available inquiry [3].

Inquiry is meant here is guided inquiry, which guided inquiry is one or the other strategy that requires students to learn the group [4]. Guided inquiry there are five phases: orientation, exploration, formation of concepts, applications and cover [5].

To implement the strategy guided inquiry in the learning process teachers need to use teaching materials. One or the other form of teaching materials that can be used by teachers to make independent students in the learning of acid-base titration is the student worksheet, because the material acid-base titration is one of the materials that have to do experiments therefore it is necessary teaching materials in the form of student worksheet for guiding students to understand and find the concept.

Teaching materials in the form of student worksheet will allow teachers to achieve the desired learning objectives. student worksheet made under Guided Inquiry learning cycle. Guided inquiry learning that is learning designed to teach students how to find a concept of the key questions.

Based on the observation of the authors at some schools in fact, the author has not found the chemistry teaching materials in the form of guided inquiry-based student worksheet especially on acid-base titration topic that can make students actively in the learning process. Teaching materials are widely available in the school library is the teaching materials are printed books that have not been able to guide the students find the personal concept and therefore the author has provided teaching materials that have been provided by developing teaching materials in the form of student worksheet based guided inquiry for the materials Titration Acid Bases. based on the description above, the purpose of this research is to generate and determine the validity and practicalities of teaching materials in the form of worksheets based guided inquiry on the matter acid-base titration.

**METHOD**

Research carried out is Research and Development (R & D). Research and development is a research method that is used to produce a particular product and test the effectiveness of these products [6]. The research model is the development of 4-D model of development, which consists of four stages: define, design, development, and disseminate [7].

In accordance with the above research and development of this research is to develop teaching materials in the form of student worksheet based on guided inquiry of chemistry learning acid base titration class XI Senior High School used by one or the other students of West Sumatera, Indonesia on the second semester of academic year 2013/2014. The development phase aims to a produce student worksheet the valid and practical, student worksheet produced is used for learning in the classroom and students independent.
Analyzed data research to use descriptive statistics to obtain average figures and percentages. The data analysis technique for each of the research data can be described as follows:

**Techniques of validity analysis**

Techniques of validity analysis to measure content validity, design, and the practicalities of categorical judgments based on modified from Boslaugh\(^8\). In the categorical judgments, the validators are given a statement to then provide an assessment of each of these statements. Sheets were given as questionnaire and at the end of the validator to be given the opportunity to decide the outcome of the judgment has been given.

Assessment validators against each statement is analyzed using Cohen Kappa formula, which at the end of the processing obtained Moment kappa.

This follow:

\[
\text{moment kappa (k)} = \frac{P - Pe}{1 - Pe}
\]

<table>
<thead>
<tr>
<th>K</th>
<th>Moment kappa showed the validity of the product</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>The proportion is realized, is calculated by the amount of the maximum value</td>
</tr>
<tr>
<td>Pe</td>
<td>The proportions were not realized, is calculated by the amount of the maximum value is reduced by the amount of the total value of the given validator divided by the maximum value</td>
</tr>
</tbody>
</table>

Table 1. Category decisions based moment kappa

<table>
<thead>
<tr>
<th>Interval</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.81-1.00</td>
<td>Very High</td>
</tr>
<tr>
<td>0.61-0.80</td>
<td>High</td>
</tr>
<tr>
<td>0.41-0.60</td>
<td>Middle</td>
</tr>
<tr>
<td>0.21-0.40</td>
<td>Low</td>
</tr>
<tr>
<td>0.01-0.20</td>
<td>Very low</td>
</tr>
<tr>
<td>0.00</td>
<td>Not valid</td>
</tr>
</tbody>
</table>

**Techniques of practicality analysis**

Similarly, the analysis of content and construct validation sheet, then the practicalities sheet of assessment obtained from the questionnaire responses of teachers and students were also analyzed using Cohen Kappa formula \(^8\).

**RESULTS AND DISCUSSION**

**Results**

Based on the objectives and procedures of the research, the produced teaching material as student worksheet based guided inquiry on the matter acid-base titration, and validation of the results obtained student worksheet by a lecturer and teachers, as well as the practicalities of student worksheet by teachers and students. Student worksheet based guided inquiry that have been made are validated by the validator. Results of expert validation (validator) is done to reveal the content validity of chemistry student worksheet.
in the form of student worksheet that have been designed to be done in the learning process in the classroom. Validator provides an assessment of the student worksheet with attention to three aspects, namely the content components, presentation components or construction, parts and components language.

1) Content Component

Results of the validation from aspects contents components of student worksheet chemistry based guided inquiry on material acid-base titration from the validator I and II have a high validity category and validators III and IV have very high validity of the category.

2) Presentation Components / Construction

Results of the validation from aspects construction components of student worksheet chemistry based guided inquiry on material acid-base titration of validator I and II have a high validity category, the validator III and IV have very high validity category.

3) Language Components

Results of the validation from aspects language components of student worksheet chemistry based guided inquiry on material acid-base titration of validator I and II have a high validity category, the validator III and IV have very high validity of the category.

Although the validity of chemistry teaching materials in the form of student worksheet has been high, but still there are some components that must be repaired.

Based on the results of expert validation for chemistry student worksheet on the material acid-base titration based guided inquiry validation of analysis student worksheet are valid with the category of high validity. There are some parts of this teaching material should be enhanced from the advice given by the validator, among others: the arrangement of key questions can still be arranged better, the key question be further simplified, taking into account the allocation of time, there are some colors that are not in accordance with student worksheet, there are some models that are less precise, there are some models that have to be added, there are several forms of molecules and molecules that are less precise colors, there are a few sentences in the fields of information that must be corrected and added, as well as the source of the model should be written.

At a later stage, conducted trials on a small group. This trial aimed to determine the practicalities of student worksheet based guided inquiry guided that developed. The practicalities of student worksheet based guided inquiry guided can see from usefulness product of the limited field trials concerning the practicality and feasibility of the products developed.

Assessment practicalities of student worksheets based guided inquiry is obtained very high at the moment kappa value of 0.81. From the results of these practicalities, the of student worksheets based guided inquiry can be applied to the learning process in school.

The practicalities of student worksheet based guided inquiry also be seen from the provision of student questionnaire responses to product-based teaching materials in the form of worksheets guided inquiry. The assessment results obtained are 0.83 of student worksheet guided inquiry obtained the practicalities of every based aspect considered very high. It can be seen from the average achieved moment kappa of all aspects assessed by category practicalities of high and very high.

Discussion

Product assessment is done by using the assessment sheet that has been validated by 4 expert evaluation. Data validation of student worksheet based guided inquiry on material acid-base titration obtained from the one ratings chemistry lecturer and three chemistry teachers. Selection of four experts examine the construct validity of this instrument, can be used on expert opinion (Expert judgment) that the number of at least three people.
Data sheets assessment validation of chemical teaching materials in the form of student worksheet berbasis is guided inquiry is then analyzed using Kappa Cohen formula. Processing of assessment data validation sheet of student worksheet from all validators. Processing of data obtained an average score of validity different four validator. Results of the validation of teaching materials in the form of worksheets from the validator I and II have a high validity category, the validator III and IV have very high validity of the category. Although the validity of student worksheet based guided inquiry on the material acid-base titration produced has been high, but still there are some components that must be rectified in accordance with the advice given by the validator. After the revision of student worksheet onmateria acid-base titration that will be developed for further tested product.

Acquisition moment Kappa (k) to express practicality of student worksheet based guided inquiry on material acid-base titration from questionnaire responses teacher assessment results indicate that the average score of the practicalities of teaching materials in the form of student worksheet obtained 0.81 with very high category, which means material LKS teaching based guided inquiry form on acid-base titration materials developed can be applied in the learning process in schools.

In the used of chemistry student worksheet based guided inquiry can lead students in finding the concept of key questions given by observing a model that focuses on student learning and teachers act as facilitators and motivators. Moreover, the presence of chemistry student worksheet in the form of produced, the expected learning process can be done more effectively and efficiently, as well as students can finish the study in accordance with the respective speeds and more independent in the learning.

Based on the practicalities of assessment instruments student questionnaire responses obtained an average value of 0.83 kappa. It is revealed that the chemistry teaching material moment in the form of student worksheet generated have practicalities of very high category to be used in the learning process. Based on the above it can be concluded that the teaching material in the form of worksheets based guided inquiry on the matter acid-base titration can guide students discover concepts and help students understand the material in acid-base titration.

CONCLUSION

Based on the research that has been done, it can be concluded that the teaching material has been produced in the form of student worksheet based guided inquiry on material acid-base titration for students of class XI senior high school which has categories validity and practicality are high.

ACKNOWLEDGEMENT

Dr. Mawardi, M.Sc., Dr. Usman Bakr, M.Ed. St. Dr. Hardeli, M.Si, Bustami, S.Pd., Jhon Hendri, S.Pd and Dra. Yustini Maaruf, M.Sc., Yulmi, S.Pd as well as all those who have helped in the completion of the research and preparation of this article.

REFERENCES


INTRODUCTION

Results of PISA and TIMSS studies that demonstrate a lack of ability of Indonesian students in the high level of reasoning and thinking, Indonesia ranking in the Programme For International Student Assessment (PISA) in 2006 is a sequence of 54 from 57 countries. Indonesia's ranking dropped dramatically in 2009 and 2012 respectively ranked 57 and 64 from 65 countries (OECD, 2012).

The facts relevant to the above results, it was found in the results of preliminary observations, shows that learning chemistry is still centered on the teacher that puts the student as a passive recipient of information. Teachers do not give a perception to connect the knowledge that students have with the material that will be taught (Slameto, 2010). Teachers still do the lecture method according Trianto (2007) including conventional learning models, so according Suyanti (2010) that the learning process as such become less meaningful and students are not actively involved. Passive student learning patterns lead students are only able to solve the problems C1 to C3, and is not able to answer the questions at the level of C4 to C6.

According to Stella Cottrell (2005) Critical thinking is a process that involves complex thinking skills and attitudes. According to Richard W. Paul in Liberna (2012) critical thinking is the intellectually disciplined process whereby a person is actively and skillfully understand, apply, analyze, synthesize, and evaluate a variety of information collected or drawn from experience, observation, reflection does, reasoning, or communication does. Fisher (2008) identifies nine indicators of critical thinking, namely: a. identify the elements in the case under consideration, in particular the reasons and conclusions; b. identify and evaluate assumptions; c. clarify and interpret the statements and ideas; d. assess the acceptability, especially credible and claims. e. evaluate the arguments of
various types; f. analyze, evaluate, and generate explanations; g. analyze, evaluate and make decisions; h. draw inferences; i. produce arguments are clear and logical.

According to Ennis (1996) there are 12 indicators of critical thinking skills, which are grouped into five aspects of critical thinking skills, namely: a. elementary clarification include: focusing questions, analyze arguments, ask and answer questions that require clarification or challenge; b. basic support (basic support), include: considering credible of source and deliberation observation; c. inference includes: performing and expensive deductions, do and consider induction, conduct and consider the value of the decision; d. Further clarification (advanced clarification) include: identifying and considering the definition of the term, as well as identifying assumptions; e. strategies and tactics includes: determining a course of action, and interact with others.

Increasing critical thinking of students in chemistry can be done by inquiry learning model that involves optimally all the capabilities of students. Teacher links the content to be studied by real-world situations and encourage students to make connections between the knowledge possessed and their application in everyday life (Ngalimun, 2014). According Hamalik (2001), the inquiry is to learn how to develop problem-solving skills using critical thinking. On inquiry learning processes are: to formulate the problem, make hypotheses, designing experiments, conducting experiments, collect data and analyze the data and draw conclusions that are part of the critical thinking skills (Roestiyah, 2001). In general, the process of learning by using inquiry learning model can retrace the steps as follows: a. orientation; b. formulate the problem; c. formulate a hypothesis; d. collect data; e. test the hypothesis; f. formulating conclusions.

Learning methods are included in the inquiry one of them is Pictorial riddle is the method to develop students' activity in small and large group discussions, through the presentation of the problems presented in the form of illustration. Kristianingsih (2010) states that the learning model pictorial riddle able to stimulate students to think critically about the issues presented in the form of a picture puzzle that can arouse the curiosity of students.

This research applying inquiry learning model is aided Pictorial Riddle at colloidal material that the students were able to connect the concept with the use of such knowledge so that raises the critical thinking skills of high school students. The purpose of this study was to determine of differences and the influence of critical thinking skills among high school students using inquiry learning model aided pictorial riddle with students in teaching using conventional models on the material of colloidal solution.

METHOD

Sample this study are two XI science classes of three XI science classes that has not been taught of colloidal material. One class as the experimental class and another class as a control class. Selection of experimental class and control class by random sampling technique (Arikunto, 2010). Forms of research conducted in this study is an experimental research model "quasy experiment design" or quasi-experimental. According Sugiyono (2009), a quasi-experimental has control groups but not be able to function fully to control external variables that affect the execution of the experiment. The design used in this study is Nonequivalent Control Group Design.

Research procedures with steps that include three stages, among others: 1). Preparation Phase: a. doing pre-research to school; b. formulation of research problems of pre-research results; c. draw up a learning tool in the form of Learning Implementation Plan; d. develop research instruments in the form of lattice test of critical thinking skills, critical thinking skills test, answer key and scoring guidelines; e. validating learning device based on the
criteria that have been made; f. revising data collection tools and learning tools; g. back validate data collection tools and learning tools; h. test research instruments; 2). Implementation Phase: a. determine the experimental class and control class as research samples; b. provide pretest about students' critical thinking skills in the experimental class and control class; c. provide treatment to the experimental class and control class, where experimental class using inquiry learning model aided pictorial Riddle and control class using conventional models; 3). Final stage: a. perform data analysis and processing research results; b. make conclusions.

Methods for measuring learning achievement indicators are test methods. Giving students' critical thinking skills tests conducted before and after the learning activities using the inquiry model aided pictorial riddle. Data collection tools are test students' critical thinking skills. Pretest is given to the class a sample before learning of the colloidal material. Then posttest given to both the same class to determine the students' ability to solve problems after being given instruction to different of learning models. Form tests used in this study is an essay test. Test questions tested for validity and reliability. Validity of the content measured by examining the suitability of each item with a material that has been given. Test the validity of the content used formulation Gregory. Essay-shaped test the reliability of the formula used is alpha formula (Suharsimi Arikunto, 2010).

\[ r_{11} = \frac{k}{k-1} \left[ 1 - \frac{\sum b^2}{\sigma^2} \right] \]

Where:
- \( R_{11} = \) Reliability is sought;
- \( k = \) Number of items;
- \( \Sigma b^2 = \) total variance of each item;
- \( \sigma^2 = \) Variance Total.

Data processing techniques with the steps are: 1) gives a score on the pretest and posttest results; 2) examine the distribution normality respectively using Chi square test; 3) if both normally distributed data then followed by t test, and if one or both of the data were not normally distributed, then the next step is used U-Mann Whitney test (Subana, 2005); 4) test the homogeneity of variance in pretest scores using F-test on each experimental class and control class; 5) the effect of inquiry learning model aided Pictorial Riddle against students' critical thinking skills measured by using effect size; 6) The calculation of the normalized gain aims to determine the increase in the value of posttest and pretest of the both class (Hake, 1998).

RESULTS AND DISCUSSION

There are differences test results of students in the two classes is due to the different treatment. In the experimental class taught using inquiry learning model aided Pictorial riddle which has six phases which orientation, formulating the problem, formulating predictions answers, collect data, discuss predictions answers, and draw conclusions, while the control class is taught using conventional learning.

Orientation phase of the experimental class, the teacher gives a small demonstration relating to the material provided, students are given the opportunity to ask questions or provide feedback. Formulate problems phase conditioned the students are directed at a problem that must be resolved to form a critical mind. The problems that challenge students to think to solve the problems. Students are encouraged to find the right answers in an effort to develop mentally through the process of thinking. Problems are displayed in the form of riddle tucked in worksheets is a problem that must be solved in inquiry. Phase of formulate predictions answers, students must first find related information as much as possible through literature that facilitate students to provide predictions temporary answer...
to a given problem. The phase of collecting data is that contains student activity capturing information to test the predictions of the proposed answers. Activities of collect information carried through experimentation, reading sources or literature other than textbooks, and so on. Questions that are guiding the students awarded for directing students to the concept of the problems mentioned in the worksheets for students to find ideas, facts, concepts, or their own understanding in groups. Based on the given question, the students complete the data obtained from the reference and link it with the knowledge that he has the riddle. Phase of discuss predictions answers, students are asked to present the results of the discussion group. Students are given the freedom to express predictions answers are provided by the data of the problems that must be completed. Other students provide feedback or questions related to the delivered by another students. The final stage is to formulate conclusions, student discussion process and analyze the results they get. Students are required to conclude based on the results of hypothesis testing.

Riddle is given an explanatory drawing of the problems given in the form of images that can stimulate the thinking of students, especially after students observe riddle and answer the questions that guide, students are invited to a discussion of the issues presented. Nonetheless, achieve a minimum completeness criteria of students in the control class and experimental class with both low, each below 30%. The low of minimum completeness criteria of students learning in the experimental class caused student learning unfamiliar with inquiry model other than the conventional model. Students are used to getting lessons with conventional models in a way that is rote lectures in terms of instructional materials and tests were given. Continuous exercise is necessary to make the process of critical thinking can be formed.

Based on the results of the indicator completeness critical thinking only on indicators of ability to draw conclusions in experimental class students who have mastery over the minimum completeness criteria. According to Ennis (1996) indicator of critical thinking has indicators think that the hierarchy of the most basic skills to the highest. Students must master the most basic skills, and then at a higher skill. The completeness of each indicator of critical thinking can be seen in Graph 1 below is a chart.
Experimental class with the number of students who take the pretest is 32 people. Pretest results showed that all experimental class students scored less than minimum completeness criteria (70). And the amount of students who take the posttest are as many as 32 people. Posttest results showed that there were 7 students in the experimental class which derive more value from a minimum completeness criteria (70). Meanwhile as many as 25 students received grades below the minimum completeness criteria. The number of students of control class who take the pretest are as many as 31 people. Pretest results showed that all the control class scored less than minimum completeness criteria (70). Posttest results showed that there were 1 students who scored in the top minimum completeness criteria (70) and as many as 30 students received grades below 70.

Statistical tests performed were normality test and U-Mann Whitney test. Based on test data processing results in two classes, concluded that there are differences in test results of critical thinking among the students taught using inquiry learning model aided pictorial riddle with students taught by conventional learning models on colloidal material in high school. Based on the hypothesis test results obtained by calculating the Z value of -3.293. Because the Z count (-3.293) ≤ -Z tabel (-1.96), then Ha accepted and Ho rejected. Concluded that there are differences in test results between students’ critical thinking are taught using inquiry learning model aided pictorial riddle with students taught by conventional learning models on colloidal material in high school.

Results of the effect size calculations showed the influence exerted by inquiry assisted learning model pictorial riddle of the students’ critical thinking skills is the experimental class is 0.61. Effect size values are then compared with the distribution Table Z in order to obtain the effect of assisted learning model inquiry pictorial riddle against critical thinking skills is equal to 29.10%.

Test Results completeness students in classroom experiment and control class and the effect of the implementation of inquiry learning model aided Pictorial Riddle of the students’ critical thinking skills can be seen in Table 1 below.

<table>
<thead>
<tr>
<th>No</th>
<th>Data Results</th>
<th>Experiment Class</th>
<th>Controls Class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Pre-test</td>
<td>Post-test</td>
</tr>
<tr>
<td>1</td>
<td>Average</td>
<td>17.03</td>
<td>55.63</td>
</tr>
<tr>
<td>2</td>
<td>Deviation Standard</td>
<td>10.07</td>
<td>15.44</td>
</tr>
<tr>
<td>3</td>
<td>% Complete (to achieve a minimum completeness criteria)</td>
<td>0%</td>
<td>21.875%</td>
</tr>
<tr>
<td>4</td>
<td>% Not Completed</td>
<td>78.125%</td>
<td>96.78%</td>
</tr>
<tr>
<td>5</td>
<td>Gain an average score</td>
<td>0.61 (moderate)</td>
<td>0.29 (low)</td>
</tr>
</tbody>
</table>

Results Table 1 above gives information that the average posttest results increased. Learning outcomes of students in the experimental class is better than learning outcomes of students in the control class. The average value posttest students in the experimental class (55.63) is higher than the average value posttest in control class (39.03), though both these classes showed less of completeness that the set (70). If seen from the percentage of the value (it not completed the minimum competence criteria) posttest, the experimental class have (it not completed the minimum competence criteria) smaller percentage (78.125%) than in the control class (it not completed the minimum competence criteria) percentage (96.78%), the gain value of the second class also showed an increase in critical thinking skills as much as 0.61 are categorized as being for classroom experiments and 0.29 are categorized as low nevertheless (it not completed the minimum competence criteria) magnitude in both classes is very large.

The low value of critical thinking test results that take aspects of C4, C5, and C6 due to students not yet accustomed to resolve the matter with the sphere, so the lack of students’
skills in reasoning. Results of interviews with teachers, students accustomed during work on the problems that took the realm of aspects to remember (C1) to apply (C3) on learning. The lack of the ability of students to reason is due to the habit of learning patterns that put more emphasis on memorizing the concepts, so that students can not use the optimal ability to solve problems that took the realm aspects of C4, C5 and C6.

CONCLUSIONS

Based on the results of research and discussion, it was concluded that there are differences in test results critical thinking among the students taught using inquiry learning model aided pictorial riddle with students taught by conventional learning models on colloidal material in high school. Learning to use inquiry learning model aided pictorial riddle on colloidal material in high school give the effect of 29.10% on improving student learning outcomes.

ACKNOWLEDGEMENTS

Thanks submitted to chemistry education courses in UNTAN pontianak and academicians, and to all the students of SMAN 1 Sambas and academicians. Thanks to the support of all parties, this study can be completed.

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THE EVALUATION AND PROGRAM IMPROVEMENT MODEL OF CHEMISTRY TEACHER PROFESSIONAL EDUCATION FACULTY OF MATHEMATICS AND SCIENCE EDUCATION INDONESIA UNIVERSITY OF EDUCATION

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INTRODUCTION

Teacher responsibility plays a very important part in life of nation and state. The quality of teachers will determine the quality of Indonesia society in future. Itelson (in Barke and of Harsch, 2001), an education expert from Russia, more than last 120 years ago (1888), believed that the mistakes of teachers in conducting their tasks will cause damage in all aspects of life (political area, law, economic, education, health, and others) around ten until twenty years later.

In line with this idea, teacher profession must be holded by professional people in educational areas so that life of nation and state be better in the future. This matter is

Abstract

The program of Chemistry Teacher Professional Education at Faculty of Mathematics and Science Education, Indonesia University of Education reside in second period training from two-semester targeted. Until now there are indications of some weakness related to participants, advisors (lecturer and teacher), attributes of program of Teacher Professional Education (TPE) including evaluation formats, equipments and facilities. Based on all of these, this TPE Program which executing. The main goals of this research is to get information about effectiveness of TPE program done and also obtained its improvement model. This evaluation research was conducted to describe about effectiveness of planning, implementation, and assessing and also improving of the program in the future. Instruments used are questionnaire, document analysis format, observation guide, interview guide, and visual audio record. Results indicate that effectiveness of planning, implementation, and assessing of Chemistry Teacher Professional Education in Faculty of Mathematics and Science Education, Indonesia University of Education can be categorized as good; model of Absortion, Doing, Interacting, Reflecting and also silih asuh (directive), silih asah (guided discovery), silih asih (receptive), and silih ajenan (exploratory) approaches can be implemented in the training giving better results. The improvement of Chemistry TPE in the future can be realized through (1) developing and implementing of Standard Operating Procedures of workshop, peer teaching, training of teaching-learning at school and classroom action research; (2) settlement of Guide Book of TPE and teaching-learning program and also classroom action research guide; (3) settlement of training lesson plan; (4) curriculum document which loaded by vision, mission, graduate profile and competencies, and subject description; (5) settlement of weighting and rubric test component, and (6) restructuring of organization system and also improving of personal performance.

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supported by Darling-Hammond and Bransford (Senate of Academic UPI, 2010) expressing that professionalism of teacher in doing their duties will determine future. Based on the Law Number 14 Year 2005 about Teacher and Lecturer, teacher as professional occupation have main duty are educating, teaching, guiding, instructing, directing, training, assessing, and evaluating of student. As professional, teacher must have competencies of pedagogical, personality, social, and professional obtained through profession education.

In relating with Teacher Professional Education (TPE), Indonesia University of Education (IUE) as Educational Institute and educational employee has been selected as committee of TPE according to Regulation of Ministry of National Education No. 8 Year 2009 about in-service TPE, and also according to Decree of The Ministry of National Education No.018/P/2009 about determination of TPE implementation. Department of Chemistry Education is one among 25 programs trusted by government republic of Indonesia as committe of program of TPE strengthened by decision letter of Rector Indonesia University of Education Number 2120/H40/DT/2009.

After implementing TPE program for almost one year, it has been found various weaknesses which must be improved and refined. Some weakness are some participant have not comprehended school chemistry subject in theoritical or practical, they have difficulty in using english texbooks; lecturer and master teacher aspect have not yet uniform in implementing TPE activities; TPE program has not yet provided completely evaluation formats which can help teacher and lecturer to easily, accurately and correctly measure participants abilities in each areas of TPE program. These above weakness require immediately correction through TPE program evaluation research. For this purpose, a research "The Evaluation and Program Improvement Model of Chemistry Teacher Professional Education Faculty of Mathematics and Science Education, Indonesia University of Education” was conducted.

METHOD

This evaluation research was conducted for 8 months, from April until November 2011 at Department of Chemistry Educatin Faculty of Mathematics and Science Education, Indonesia University of Education and seven high schools located in Bandung city, namely SMAN 1, SMAN 2, SMAN 4, SMAN 6, SMAN 14, SMAN 16, and SMAN 18.

This evaluative research was to both describe the effectiveness of planning, implementation, assessing of Chemistry Teacher Professional Education Program and to develop its improvement model. Research subject consists of 24 TPE participants, 12 Lecturers, 7 teachers, 7 High School Headmasters, 3 TPE committee, and the head of Department of Chemistry Education (DCE) Faculty of Mathematics and Science Education (FMSE).

The research instruments used were questionnaire, document analysis formats, observation guide, interview guide, and visual audio record. Questionnaire and interview guide were used to gather information about planning, implementation, assessing, and improving of training program based on the perceptions of participants, lecturers, teachers, and headmasters. Document analysis format was used to collect information about documents feasibility for preparing TPE program such as guide book of TPE program, syllabus of each course, lesson plan units, teaching materials, and assessing instrument packages. Observation guide was used to collect information about guidance activities, laboratory works, peer teachings, teaching practices, and classroom action research. Data were first collected and then processed into tables, graphs or
narration. Data analysis about planning, implementation, and assessing was done qualitatively. Furthermore, the data were categorized and compared with standards. While data of participant’s products like compilation of lesson plans and their teaching performance in peer group or real class, and graduating from TPE program was analyzed quantitatively.

RESULTS AND DISCUSSION

The Planning Effectiveness of Chemistry TPE Program

1. The planning effectiveness of Chemistry TPE program is divided into two parts, these are academic and administrative planning effectiveness. Academic planning effectiveness represents activities to prepare materials which can be used educate and train TPE participants so they have knowledge and skills needed to prepare professional chemistry teacher. While administrative planning represents activities to prepare mechanism and technical aspects supporting TPE program to be succeed and reach target well.

2. The planning effectiveness of TPE program is measured through the opinion of lecturer, teachers, school headmasters, and participants of Chemical TPE. The respondents gave their perceptions related to the various documents which have been prepared by Chemistry TPE program concerning all above planning aspects. Furthermore, based on respondents perceptions, the percentage of planning effectiveness Chemistry TPE program is determined. Figure 1 shows the TPE program planning effectiveness in both academic and administrative planning.

Figure 1 Profile of The Planning Effectiveness Chemistry TPE Program

PREPARING OF:
1. Implementation Guide of Chemistry TPE
2. Curriculum of Chemistry TPE
3. Syllabus and Lesson Plan of the TPE Program
4. Teaching Materials (TM) about Student Misconception in chemistry
5. TM about Graduate, Content, Process, and Evaluation Standards
6. TM about Syllabus of Chemistry for High School
7. TM about Lesson Plan Example
8. Guide of Teaching Practice at School
14. Evaluation Instrument for Non Teaching
15. Evaluation Instrument for Social and Personality
16. Evaluation Instrument for Teaching Practice Report
17. Evaluation Instrument for Classroom Action Research (CAR) Proposal
18. Evaluation Instrument for CAR Report
19. Testing Instrument of Teacher Competencies
20. Organization System of TPE Program
21. Dissemination of TPE Program
22. Participant Recruitment
9. Guide of Classroom Action Research
10. Evaluation Instrument for Program Graduation
11. Evaluation Instrument for Workshop
12. Evaluation Instrument for Lesson Plan
13. Evaluation Instrument for Peer Teaching
23. Lecturer and Teacher Recruitment
24. Partnership School
25. Implementation Technical for Workshop, Peer Teaching, Teaching Practice, and CAR

Based on Figure 1, it can be expressed that activity planning of Chemistry TPE Program in Faculty of Mathematics and Science education, Indonesia University of education is categorized very good. For both types of planning, their averages are above 95%. However, there is still a number of planning aspects needed to be improved as shown in the figure 2 so that the planning of Chemistry TPE program even better.

The Implementation Effectiveness of Chemistry TPE Program

The planning of Chemistry TPE program is categorized very good, however, it is useless if it cannot be implement well. Therefore the evaluation of implementation step was conducted. The evaluation of Chemistry TPE Program was conducted at all phases, namely (1) program socialization, (2) workshop, (3) peer teaching, (4) teaching practice and (5) Classroom Action Research (CAR).

Similar to the evaluation of the planning of TPE Program, the implementation effectiveness of Chemistry TPE Program was based on opinion of Lecturers, teachers, Headmasters, and Participants at all phase implementation of TPE Program. Furthermore respondents’ perceptions were organized and expressed by percentage. Following Figure 2 shows the implementation effectiveness of five phase of implementation TPE program.

Based on Figure 2 above, it can be expressed that implementation activities of Chemistry TPE Program in Faculty of Mathematics and Science education, Indonesia University of education is categorized very good. The effectiveness in the five phase of Chemistry TPE Program has average above 90%. But there is still a number of improvement should be done so that the implementation of Chemistry TPE program become even better. Among the above phases, improvement of CAR is a top priority.
The Evaluating Effectiveness of Chemistry TPE Program

Assessing of Chemistry TPE Program in Faculty of Mathematics and Science Education, Indonesia University Education was conducted to all steps of TPE Program implementation including (1) workshop, (2) peer teaching, (3) Teaching Practice in real class, and (4) Classroom Action Research. For each step, assessment was done to all targets, namely, committee, lecturers, teachers, and participants.

The evaluation of the effectiveness of TPE program was done by using various documents showing performances of all personal targets and all activities above mentioned. Based on the documents, furthermore the data were weighted and classified and then qualitatively categorized into Very Good (CG), Good (G), Average (A), and Poor (P). Following Figure shows the evaluation effectiveness of TPE Program in all phase mentioned above.

![Figure 3 Profile of The Evaluating Effectiveness Chemistry TPE Program](image)

1. Performance of Committee at workshop
2. Performance of Lecturers at workshop
3. Performance of Teachers at workshop
4. Performance of Participants at workshop
5. Performance of Committee at peer teaching
6. Performance of Lecturers at peer teaching
7. Performance of Teachers at peer teaching
8. Performance of Participants at peer teaching
9. Performance of Committee at teaching practice
10. Performance of Lecturers at teaching practice
11. Performance of Teachers at teaching practice
12. Performance of Participants at teaching practice
13. Performance of Committee at CAR
14. Performance of Lecturers at CAR
15. Performance of Teachers at CAR
16. Performance of Participants at CAR

If above qualitative data are changed into quantitative data, for example VG = 90; G = 80; and P = 70, hence the average score of all TPE Program phase is 82. Thus, it can be expressed that the evaluation of all target in Chemistry TPE program step is good (B). If the same calculation is applied to all step, hence there is no difference among average of all steps. Even though, CAR step gets the smallest average (smaller than 80). Based on this, CAR step must get priority to be improved.

If the same calculation was done based on the targets (committee, lecturers, teachers, and participants), participants got the best performance score. Based on the above figure, some should be done by committee, lecturers, teachers, and participants to obtain a better performance.

The Improvement Model of Chemistry Teacher Professional Program
The Implementation of Chemistry TPE Program in Faculty of Mathematics and Science Education, Indonesia University of Education was based on the ADIR (Absorbing, Doing, Interacting, Reflecting and) model and applied approaches of "silih asuh (directive), silih asah (guided discovery), silih asih (receptive), and silih ajenan (exploratory)" among committee elements, lecturers, teachers and participants. The improvement of the program was focused to reduce weakness observed during steps workshop activities, peer of teachings, teaching practices and CAR. Reducing the weakness was also done at phase the planning, implementation, and assessment of Chemistry TPE Program.

Based on the effectiveness of planning, implementation, and evaluation mentioned previously, here are some basic principles which should be done to improve Chemistry TPE program. They are both revitalization the intensity of absorbing, doing, interacting activities which are reflected by using approaches of silih asuh (directive), silih asah (discovery guided), silih asih (receptive) and silih ajenan (exploratory) and application of relevant methods and real activities.

The tables 1 below expresses efforts needed to improve Chemistry TPE program at each step, workshop, peer teaching, teaching practice, and CAR related to models, approaches, and selected methods. Urgent improvements should be done in following aspects (1) Harmonizing document of Chemistry TPE program guide issued by national deliberation with the redesign book of TPE delivered by Indonesia University Education 2010 edition, (2) Providing the document of quality assurance system at Chemistry TPE guide with its Standard Operating Procedure (SOP) for the workshop, peer teaching, teaching practice and of CAR, (3) Developing of curriculum document containing vision, mission, target, graduation profile, graduation competencies, implementation strategies of mission and vision, organization managerial system, job description of every committee, learning objectives, kinds of courses, courses code and credit hours of courses, course description, reference of courses, syllabus framework, lesson plan framework, and type of assessment instruments. (4) Arranging of assessment instruments with high validity, so that can express performance of the committe, Lecturers, teachers and participants more objective and realiable. (5) Developing CAR guide to build the same perception between that of lecturer and teacher so that the CAR implementation is better. (6) The integration of TPE program into regular program of Chemistry Education Department, so that the class room and laboratory needed for TPE program are well scheduled. (7) Asking for chemistry teachers in partnership school to coordinate with others, so that frequency of participants teaching practices in schools is more. (8) Intensify cooperation between TPE program and professional organization to enable competency test more credible.

CONCLUSION

Based on above research findings can be formulated some conclusions as follow. In general the planning of administrative and academic of chemistry TPE Program at Department of Chemistry Education Faculty of Mathematics and Science Education, Indonesia University of Education can be categorized to have already fulfilled the main goals of pre-service TPE program. The planning of Chemistry TPE program produced implementation TPE program guide, syllabus and lesson plan, teaching-learning materials such as comment students misconception of chemistry concepts, standards of high school graduation, content standard of chemistry subject, process standard of teaching implementation, evaluating standard of instruction, teaching pratice guide and some evaluation instruments for workshop, lesson plan, teaching performance, non teaching activities, social and personality competencies, teaching practice report, comprehensive of
teaching practice, classroom action research proposal and report, items test of competency, and graduate determination from chemistry TPE program.

The implementation chemistry TPE Program was carried out in the form of workshop, peer teaching, teaching practice. They were generally done well and categorized fulfilled the main goals of TPE program, with exception the implementation of CAR not yet done intensively. Workshop was focused on preparation of instruction package documents provided with map concepts, student worksheets, teaching materials, experiment activity sheet, teaching media, and instructional items test. Workshop was conducted at Department of Chemistry Education with team-work system, with 3-4 members and guided by two counselors, namely a Lecturer and a Teacher. Workshop at semester 1 and semester 2 each took 9 weeks. Those activities gave participants experiences to compose 6 lesson plan with its attributes. Through sharing with colleague, all participants (24 peoples) have yielded 25 chemistry lesson plan (CLP) for high school grade X, 36 CLP for high school grade XI, and 37 CLP for high school grade XII. Peer Teaching represented the part of workshop, performed at Department of Chemistry Education and each participant performed as teacher in peer teaching 6 times. Teaching practice at semester 1 was implemented at 8 high schools located in Bandung city and semester 2 at 7 high schools at the same city. During teaching practice program, each participant of TPE have experienced for presenting some chemistry topics at X, XI, and XII grade. During teaching practice in school, participants did school observation, non teaching activities, social interaction with school personals. During this period, they should also show good personality and at the end of the period must pass the final examination of teaching practice. They also have experiences to compose CAR proposal based on crucial problems gained during their teaching practice in schools or teacher experiences, while its implementation was done just by small number of the participants.

In general assessment to implementation of Chemistry TPE program can take place according to good guidance at step of workshop, peer teaching, teaching practice, and CAR. The performance of committee, lecturers, teachers, and participants in each activity is categorized as good but in certain aspects still require improvements. Committee teams have produced of time schedule, various of assessment instruments, teaching materials, work place, attendance list, collecting all of participants work products, collecting of assessment results, value processing, salary and consumption distribution. Lecturers and teachers have produced training syllabus, showing ability guidance, assessing ability, da not seriously implement their duty and report result of activities. Performance of participants was increased in areas pedagogical competencies likes in making of lesson plan and teaching ability, professional competency likes in mastering of school chemistry concepts, and experimental skills, social competencies such as in communicating and social interaction with student and school personals, and personality competency like in presenting buttonhole as teacher. Training of chemistry TPE program was conducted through model of Absorbing, Doing, Interacting, Reflecting (ADIR) and applying approaches of silih asuh (directive), silih asah (guided discovery), silih asih (receptive), and silih ajenan (exploratory). The improvement of the program was focussed on the settlement of vision, mission, organization structure, academic document, administration technical, facilities, and personals performance.

REFERENCES


EMPOWERING CHEMISTRY TEACHER IN PRODUCING DIGITAL MEDIA TO INCREASE STUDENTS’ GENERIC SCIENCE SKILLS AND CRITICAL THINKING SKILLS

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INTRODUCTION

Indonesia is the fifth of biggest populations on the world as country with thousand’s island and hundred’s ethnic and languages. More than seventy percent population in Indonesia use internet, it’s mean about 71,190,000 as internet user, and its will increase continuously (figure 1). The high number of internet user is potentially to increase educational quality by integrating ICT into class.

As a developing country Indonesia has many problems including educational problem. One of the educational problems is the low teacher ability to integrate ICT on their class. Many resources on the internet can be used as media in teaching and learning process. But the media in the internet mostly were not improved student’s generic science and critical thinking skills completely. Therefore teachers should be trained to compile those media, so the internet-based media can be used in their class. Firstly they had to analyze the media using special format. Then they had to compose new models of media that fulfill the goal of chemistry learning. The result of media composing will be used in chemistry lesson. Training of 16 Chemistry teachers from Bandung, Cimahi, Sumedang, and Garut, have been done at 30 June – 1 August 2015 give several media that have constructed about 2 Chemistry topics, i.e. ‘rate of reaction’ and ‘osmotic pressure’. The media result should be tryout in high school.

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to increase chemistry teachers’ ability to integrate ICT-based media, especially to increase student generic science skill and critical thinking skill. To integrate ICT in teaching and learning process, the first step have to do is making teacher become literate to the ICT.

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Users</th>
<th>Growth Rate</th>
<th>New Users</th>
<th>Country Population</th>
<th>Primary Change</th>
<th>Secondary Change</th>
<th>Internet Usage</th>
<th>Total Users</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>30,358,024</td>
<td>9%</td>
<td>2,980,003</td>
<td>212,835,393</td>
<td>1.0%</td>
<td>1.72%</td>
<td>3.4%</td>
<td>33</td>
</tr>
<tr>
<td>2015</td>
<td>34,296,082</td>
<td>2%</td>
<td>3,645,002</td>
<td>248,503,393</td>
<td>1.36%</td>
<td>1.70%</td>
<td>3.4%</td>
<td>32</td>
</tr>
<tr>
<td>2016</td>
<td>39,358,046</td>
<td>2%</td>
<td>3,645,002</td>
<td>248,503,393</td>
<td>1.36%</td>
<td>1.70%</td>
<td>3.4%</td>
<td>32</td>
</tr>
<tr>
<td>2017</td>
<td>45,420,910</td>
<td>2%</td>
<td>3,645,002</td>
<td>248,503,393</td>
<td>1.36%</td>
<td>1.70%</td>
<td>3.4%</td>
<td>32</td>
</tr>
<tr>
<td>2018</td>
<td>52,582,782</td>
<td>2%</td>
<td>3,645,002</td>
<td>248,503,393</td>
<td>1.36%</td>
<td>1.70%</td>
<td>3.4%</td>
<td>32</td>
</tr>
</tbody>
</table>

**Figure 1.** (a) Number Indonesia internet user by year. (b) Asia top ten internet user

Teachers would be wise and advises to select abilities that represent that they want students to be able to do. Teacher must select the best media to help teacher deliver concept to student. Unfortunately not all the media that exist on the internet can help student to understand about the concept and develop critical thinking skills and generic science skills. Current areas of interest in Chemistry education include students’ conceptual understanding through multiple representations and the use of technology to shape students’ reasoning. Based on the explanations, teachers should be trained how to use ICT to enhance students’ thinking skill that will be developed.

**METHOD**

Training was conducted at Department of Chemistry Education in three days. Day 1, teacher afforded by several topics such as generic science skills, critical thinking skills, multiple representation, and internet searching skills. Teachers learned on how to download media from the internet, and how to analyze media that have been downloaded to develop generic science skills, critical thinking skills and multiple representations of chemistry concepts. Day 2, the media that has been downloaded by teachers, and then analyzed by them using special worksheet. Day 3, the teachers decided topics integrated ICT-based media for developing lesson plan for learning Chemistry of high school students.

**RESULTS AND DISCUSSION**

Day 1, first session, teacher learning about generic science skills and critical thinking skills. At the second session, teachers learn about multiple representations that create mental models. Next session, teachers learn about impact of ICT into education, especially in the teaching and learning process. The last session of day 1, teachers learn to analyze media from internet. Before analyzed the media, teachers have to search media from internet and downloaded it. During this time, most of the teachers have good ability in searching media, but they have not tools to download it, especially how to download flash media. In this training teachers learn to download media using free tools.
software Orbit Downloader. On the end of the day 1, tutor give a home work to the teachers to download media and analyze it for the next day.

FIGURE 2. (a) Teacher’s media, inserting media from internet into PowerPoint. (b) A part of Media analysis worksheet.

The result teachers’ analysis of medias can be seen in figure 3

FIGURE 3. Results (a) Analysis of Multimedia, (b) Analysis of Content, (c) Analysis of Generic Science Skills, and (d) Analysis of Critical Thinking Skills
Day 2, during this time, teachers discuss each other to analyze and determine Chemistry topics that will be presented in senior high school, after that they analyze the related media. They divided into three groups and each group creates different class level media related on topics. Lesson plan that they create, must integrate media from internet they was analyzed. Two topics was selected to implement on day 3, there are osmotic pressure and chemical rate of reaction. Two teachers from MAN 2 Bandung will teach on their class using lesson plan that they were created.

When teacher created lesson plan, the main problem was not one media that was downloaded completely they are needed. It means they have to modify or combine more than two media for their lesson plan. It has been happened, because media developer has a different purpose with teachers. The media was not specifically made to develop critical thinking skills and generic science skills. With this reason, teacher have to choose the part of the media that usable for their lesson. Media that will use at the implementation day creates from several source and they combined in one file by Microsoft PowerPoint. The lesson plan will be implemented in MAN 2 Bandung.

REFERENCES


THE DIDACTICAL DESIGN TO DECREASE STUDENTS’ LEARNING OBSTACLES IN THE NOMENCLATURE OF SIMPLE INORGANIC AND ORGANIC COMPOUNDS

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INTRODUCTION

Permendikbud No. 65 Year 2013 stated that the process of learning in the educational unit organized in an interactive, inspiring, fun, challenging, motivating students to actively participate and provide enough space for innovation, creativity, and independence in accordance with their talents, interests, and physical and psychological development of students (Kemendikbud, 2013).

Facts on the ground indicate that the potential of Indonesian students still untapped optimally reflected from the publication of new international survey by PISA (Programme for International Student Assessment) and TIMSS (Trends in International Mathematics and Science Study) that always puts Indonesia in the lowest position among other countries (Litbang Kemendikbud, 2014). This is reinforced by the results of observations conducted by researcher at one high school in Bandung, West Java province, Indonesia, which indicates that the learning is actually happening in the field have not led to the development of contextual learning, skills attitudes and skills. In the learning, a teacher tend to lecture, students listen only, although there are some students were active discussion, they are not necessarily talking about the lesson is. In addition, if students ask the teacher failed to give other students a chance to answer in this case study has not been seen leading a group of students to discuss with peers.

In the study of chemistry found many learning obstacles, one of them on the material nomenclature simple inorganic and organic compounds. Students can not write index numbers in the chemical formula of the compound properly, so many errors, both in determining the name of a compound or chemical compounds of formula (Faiz et al.,...
2012). Students have learning obstacles in understanding the nomenclature of chemical compounds amounted to 43.33%, this is because the concept of a compound name is a matter of memorizing (Susanti and Lutfi, 2014). Moreover, to understand the material chemical nomenclature, students must understand the material prerequisites. The material prerequisites associated with the symbol and the name of the element, the charge, as well as oxidation state. Therefore, teachers must pay attention to students' learning obstacle in particular epistemological obstacle.

One alternative learning to decrease learning obstacle by making the design didactic. Didactic design can be an alternative to learning to decrease learning obstacle students in understanding the concept of the kite and rhombus in mathematics (Chairani 2012). The study is in line with Yuhelman (2014) results showed that the design of didactic lesson aided analysis to decrease students' learning obstacle on the concept of solubility and solubility product. The next question is, How didactic design can decrease of students' learning obstacle in the learning nomenclature simple inorganic and organic compounds?. In this study focused on the analysis of design didactic learning obstacle, in particular on the learning aspects of epistemological nomenclature simple inorganic and organic compounds.

**METHOD**

The method used is descriptive qualitative with purposive sampling technique. This study was conducted in one high school (SMA) in Bandung, West Java province, Indonesia. Subjects in this study consisted of students of class X, XI, IPA and a teacher. The procedure of this study are 1) Analysis of the situation didactic before learning. 2) Analysis of the current situation of learning or didactic metapedadidaktis analysis. and 3) Analysis of the situation after learning or didactic retrosfektif analysis.

In this study used four instruments, they are: Respondents Ability Test (RAT), interview, observation (camcorders and recorders), study the documentation. RAT is a written test in the form of a description which consists of six questions. RAT done twice, they are RAT beginning and end. RAT implementation goal is to determine the student's learning obstacles in the nomenclature of simple inorganic and organic compounds. Observation sheet used to obtain a clear picture of the interactions that occur in the process of learning in the classroom. Observations assisted by a camcorder during the implementation process didactic design. The questionnaire used to gather information on the depth of understanding of related nomenclature simple inorganic and organic compounds. The tape recorder is used as a recording device at the interview stage after RAT implemented.

**RESULTS & DISCUSSION**

Characteristics of students' learning obstacles identified through answers Ability Test results Respondents (RAT) early, given to students of grade XI, interviewing some students and chemistry teachers. The students' learning obstacles are , Students' have difficulty when naming ionic compounds, covalent, acids, bases and which involve an element of transition. In addition, students do a lot of technical mistakes such as misspelled names of elements, and the placement of Roman numerals. The following is one matter of RAT.
Based on the results of the work in a matter of two numbers, the expected response is copper(I) sulfide to Cu₂S, magnesium bromide to MgBr₂, sodium chloride to NaCl, calcium carbonate for CaCO₃. While the percentage gained is to see how big the students’ learning obstacles in answering nomenclature ionic compound. Unknown percentage of 30 who answered correctly with a score of 20 is as much as 3.33, a score of 15 of 30, a score of 10 as many as 56.7, a score of 5 as much as 6.7 and a score of 0 by 3.3. Acquisition illustrates the percentage of students’ abilities and students' learning obstacle in doing the second question regarding the nomenclature of ionic compounds. Barriers to learning are supported by interviewing students and teachers. The following interview excerpt students:

Subject Time Conversation
Peneliti 44-49
Kalau menurut agam nih, soal yang tadi tatanama, termasuk kategori sedang, mudah atau sulit ?
Siswa 50-01.03
Sebenarnya sih mudah ya kalau kita apal, cuman inikan pelajaran yang setahun lalu, sama sekarang udah engga belajar yang itu lagi, jadi sedikit lupa, jadi mungkin masuk kategori sedang.
Peneliti 01.04
Dari soal tadi yang paling sulit nomor berapa ?
Siswa 01.05-01.15
Yang nomor 1, 2, 3 kayaknya.

The following excerpt teacher interviews:
Peneliti : Konsep apa yang sulit di ajarkan ke siswa?
Guru : Konsepnya tidak begitu sulit ya, tapikan karna unsurnya banyak, nah yang dihapalnya banyak itu yang menjadi sulit, misalnya karbonat, trus nitrat itu ya yang bikin sulit, trus unsur - unsurnya bnyak dan sebagainya itu yang bikin sulit.
Peneliti : Bagaimana hambatan belajar yang siswa hadapi menurut ibu ?
Guru : Ya itu kebanyakan unsur, anak jadi males, kan waktu dulu kelas X tahun 2013 sudah IPA kan dituntut harus hapal, jadi ya itulah karna banyak unsurnya jadi malas untuk belajar.

In a conversation snippets students with researchers showed the students do not understand the subject matter of nomenclature simple inorganic and organic compounds. The description of the teachers stated that learning nomenclature simple inorganic and organic compounds are taught by rote. How to learn to memorize causes lazy to learning, it caused students can not fully understand the concept of the nomenclature simple inorganic and organic compounds.

The design of this teaching are the didactic situation (relationship with the material), in anticipation of didactic pedagogical (teacher actions performed based on predictions of students' response to the situation created didactic) to achieve the expected competencies.
Didactical design consists of chapter design (CD) and lesson design (LD) is equipped with a predicted response of and teachers antipasti and worksheets used to handle. Lesson design to decrease students' learning obstacles can be seen in Figure 1. The draft guiding students to observe the regularity of nomenclature of some compounds exemplified teacher on the whiteboard, then is able to find a pattern of a compound name. The discovery of the pattern of names on the ability to deliver compounds to name compounds tend to avoid rote learning, so that students understand the lesson well.

**Figure 1.** Lesson design to decrease students’ learning obstacles

Implementation of the initial didactic design given to high school students of grade X IPA. Lessons are conducted twice meetings. At the first meeting of the lesson taught nomenclature nomenclature of inorganic compounds include a binary (ionic and covalent), polyatomic, acids and bases. At the second meeting of the lesson taught nomenclature of compounds involving transition elements (binary and polyatomic) and enrichment materials nomenclature of organic compounds include alkanes, alkenes, alkynes and alcohol. Student responses appear as a whole in accordance with the predictions of the teacher, students can determine the pattern of nomenclature seen from some of the examples provided by the teacher. Students can determine the pattern of a nomenclature of compounds. If the students’ difficulty in giving a name, then the teacher gives a little help in the form of some questions refer "binary compound covalently it consists of what elements", if the student is still confused, given the questions referring again in the form of "whether there are metal and nonmetal" until students can determine that binary ionic compound composed of a metal element + nonmetal + ida after the students were given the strengthening of the ways students are asked to name some of the chemical compounds on the worksheet.

After implementation, are given tests the ability of respondents and interviews to check the students’ learning obstacles. Based on the test results of ability respondents found that
there are still students' learning obstacles on the concept of nomenclature polyatomic compounds and compounds which involve elements of the transition, but the overall students' learning obstacles has been decreased. This is supported by the results of the researcher interviews, the following excerpts:

Peneliti: Bagaimana menurut anda tetang soal yang diberikan, mudah, sedang atau sulit (berkaitan dengan penamaan senyawa anorganik dan organik sederhana) ?
Siswa: Dari keseluruhan mah soalnya dikategorikan sedang, karena disetiap soal itu beda pemahamannya juga, di soal bagian awal, pemahamannya ga begitu sulit

Peneliti: Bagaimana menurut anda, cara guru mengajarkan penamaan senyawa anorganik dan organik sederhana?
Siswa: Enak, sreg, masuk banget, soalnya karna dari sistem belajarnya juga dikelompokkin, trus juga ga cepet-cepet juga, jadi dari kitanya semangat untuk mengerjain, ngerti banget saat diterangin.

Peneliti: Apakah ada perbedaan belajar seperti biasa dengan dibandingkan belajar tata nama senyawa ?
Siswa: Beda banget soalnya, pembelajaran sebelumnya sendiri-sendiri dan diterangin langsung to the point, jadi kalau kita ga ngerti ya mau gak mau kitanya ngerti beda banget yang pas pembelajaran itu, lebih enak, yang lain juga ngomongnya gitu. Pembelajarannya dibikin aktif anak-anaknya juga melalui kelompok.

Based on the results of the excerpts to prove that students are able to complete the whole matter, even though the students had a little students' learning obstacle. When students were asked with regard to teaching and learning that is done by teachers, students feel more familiar with the design of didactic researchers designed and group learning how to make students active.

Didactic design revisions in both required learning time with good management and strengthening the concept of nomenclature that involves a transition compound.

CONCLUSIONS

This type of research has been done qualitative research, is not general. The findings obtained in the form of a series of descriptions of the phenomenon studied subjects. Based on the research that has been done on the subject of research, it could be concluded as follows: Based on the findings of the students' answers on the respondents ability tests and interviews several identified that students have learning obstacles when naming simple inorganic and organic compounds. Design of didactic material nomenclature simple inorganic and organic compounds created by respondent ability testing (RAT), to decrease students' learning obstacles.

ACKNOWLEDGMENTS

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INTRODUCTION

Yogurt is a nutritious beverage, made through a process of fermentation of milk using lactic acid bacteria. The fermentation process to make the lactose in the milk is reduced, safe to eat people who are allergic to milk. In addition to animal milk also known as vegetable milk such as soy milk. Soy milk and cow's milk has proteins that are relatively the same, namely 3.5-4%. To improve the nutritional value of processed beverage products is usually done through fortification. Fortification is the addition of one or more nutrients into food for example by micro nutrient like vitamin or mineral. Fortification in foodstuffs other protein sources such as milk, soy milk and yogurt. Fortification Vitamin C (L-ascorbic acid) can function as antioxidants, and antioxidants can act to prevent degenerative diseases. Many sources of vitamins which are lemons. The addition of lemon juice as a source of vitamin C into a soy yogurt will generate multifunctional beverage. The problem is how to get fortified yogurt lemon juice, which is appreciated by the public.

Development of soy milk into a soy yogurt (soygurt) starts for the distinctive smell of soy milk are less preferred by consumers. Soybeans are very important for the prevention and treatment of certain chronic diseases such as cancer, atherosclerosis, osteoporosis, and kidney disease. The addition of mango extract soy milk to increase the content of vitamin A, C and minerals. According to Santoso, in general, soy milk has a vitamin B1, B2, niacin, pyridoxine and vitamin B group is high. Other vitamins contained in sufficient quantities is vitamin E and K, while vitamin C is contained in small amounts.
Vitamin C (L-ascorbic acid) is a non-enzymatic antioxidant that can be sourced from a lemon. Vitamin C acts as an antioxidant can both water soluble and effective as free-radical scavengers. L-ascorbic acid reaction with free radical DPPH (1,1-Diphenyl-2-picrylhydrazyl) have been studied. Antioxidants act to neutralize free radicals and prevent damage to normal cells in the body. According to the USDA National Nutrient data base in 100 grams of lemon (Citrus limon) vitamin C contained as much as 53 mg or about 88%. It required the fortification of vitamin C sourced from the lemon juice soy dairy products such as yogurt. However, the production of soy milk-based yogurt fortified with vitamin C derived from lemon juice has never been done.

This research will be conducted yogurt production with the addition of lemon juice as a source of vitamin C. The production is done by varying the ratio between soy milk (base material) with lemon juice (a source of vitamin C) to obtain quality yogurt, which is favored by the public and the levels of antioxidants high. A test (hedonic test) is done for smell, flavor, color and texture, while the content of antioxidants tested using DPPH method.

**EXPERIMENTAL METHODS**

**Soy yogurt making**
Soy yogurt obtained by 1 L of soy milk added to the skim milk in the ratio 2 : 1 is pasteurized at a temperature between 80 °C to 90 °C for 30 minutes. The resulting mixture is cooled to 43°C, added bacteria starter mix, which consists of L. bulgaricus and S. thermophilus which have been adapted, as much as 5 percent of the volume of the mixture. Results were incubated at 40 °C for 6 hours.

**Fortified yogurt making**
Fortified yogurt is made by mixing soy yogurt and lemon juice in a ratio of 9 : 1 (L1); 8 : 2 (L2) and 7 : 3 (L3). Each mixture was homogenized with stirring and kept at a temperature of 4°C. Products without the addition of lemon juice is used as control (L0). Lemon juice is obtained through extortion and sterilized using a Millipore filter membrane pore size of 0.2 μm - 0.45 μm.

**Ascorbic Acid Assays**
Ascorbic acid assay performed by titration iodimetri. 1 mL of iodine equivalent to 0.88 mg of ascorbic acid. Ascorbic acid content in lemon juice calculated using the formula:
\[
\text{Ascorbic acid titer} = \text{Vol (mL)} \times \text{mg of ascorbic acid (mg / ml)} \times \text{fp}
\]
Description:
\[
\text{Vol titer} = \text{the volume of iodine used (mL)}
\]
\[
\text{fp} = \text{dilution factor}
\]

**Antioxidant Activity Test**
Testing of antioxidant activity using methods. Antioxidant activity test carried out on a sample consisting of lemon juice, soy yogurt, and yogurt fortified lemon juice. The sample solution is made by 0.5 mL of the extract was added 3 mL of methanol and 0.3 mL of 0.5 mM DPPH. The reference solution is made by means of 3.3 mL of methanol with 0.5 mL of sample. Control solution made by mixing 3.5 mL of methanol with 0.3 mL of 0.5 mM DPPH. Each solution was shaken and incubated at room temperature for 100 minutes.
Absorbance was measured using a UV-Vis spectrophotometer at a wavelength of 517 nm. Antioxidant activity (AA) is calculated using the following formula:
\[
% \text{AA} = 100 - [\text{(sample-Abs Abs blank)} \times 100] / \text{(Abs control)}
\]

Description:
Abs sample = absorbance measured in the sample solution
Abs blank = absorbance was measured at blank solution
Control Abs = absorbance measured in the control solution

**Sensory Test**
Samples yogurt fortified juice lemon coded with random three-digit number for L1 (9:1), namely 668, L2 (8:2), namely 685, and L3 (7:3), namely 831. While L0 as a control product given the code 449. The four samples were analyzed preference level (hedonic) for color, smell, flavor and texture by 25 panelists.

**RESULTS AND DISCUSSION**

**Production of Soy Yogurt**
Soy yogurt is made through several stages of the pasteurization, inoculation and fermentation starter. The process of pasteurization of milk (soy milk and skim milk) aims to kill pathogenic microorganisms that may interfere with the growth of starter bacteria are *Lactobacillus bulgaricus* and *Streptococcus thermophilus* during fermentation. Pasteurized a mixture of soy milk and skim milk rather thick. Skim milk is added as soy milk has different types of carbohydrates are oligosacharides that can not be used as an energy source by the starter culture.

The incubation mixture of milk and starter that has been adapted, performed by varying incubation time (3 hours, 6 hours and 9 hours), at 40 ° C to get the pH and viscosity of soy yogurt desired, results can be seen in Table 1.

<table>
<thead>
<tr>
<th>No.</th>
<th>Time Incubation (h)</th>
<th>pH</th>
<th>Viscosity (DPAs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>4.55</td>
<td>2.40</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>4.15</td>
<td>2.60</td>
</tr>
<tr>
<td>3</td>
<td>9</td>
<td>3.98</td>
<td>2.90</td>
</tr>
</tbody>
</table>

Table 1 shows that the longer the incubation time can lower the pH and increase the viscosity of the soy yogurt. Results soy yogurt while optimization of the incubation time is compared with the data of the Indonesian national Standard (SNI) for yogurt as shown in Table 2 below.

**TABLE 1. The Data of pH and viscosity Soy Yogurt Time-Varying Incubation**

<table>
<thead>
<tr>
<th>Criteria Test</th>
<th>Yogurt Specifications (SNI)</th>
<th>Yogurt Specifications SNI 01-2981-1992</th>
<th>Yogurt Specifications SNI 01-2981-1992</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>Viscous liquid</td>
<td>Viscous liquids</td>
<td>Viscous liquids</td>
</tr>
<tr>
<td>Odor</td>
<td>Normal/ typical</td>
<td>Typical (tofu like)</td>
<td>Typical (tofu like)</td>
</tr>
<tr>
<td>Flavor</td>
<td>Acid taste/ specific</td>
<td>Acid</td>
<td>Less</td>
</tr>
<tr>
<td>Texture</td>
<td>Homogeneous</td>
<td>Homogeneous</td>
<td>Homogeneous</td>
</tr>
<tr>
<td>pH</td>
<td>4-4.5</td>
<td>4.55</td>
<td>4.15</td>
</tr>
</tbody>
</table>
Based on the table 2, it can be concluded that, incubation time 6 hours produce soy yogurt with a texture in the form of a viscous fluid, homogeneous, specific smell, taste sour and are in the range of pH 4-4.5, according to the data SNI yogurt. So selected incubation time of 6 hours as optimum time the production of soy yogurt.

Production fortified Soy Yogurt Fruit Lemon

Use of mature lemon fruit because a lemon fruit due to the maturity level that has the best quality, can produce a lot of juice and vitamin C is high enough. A 664 g of fruit juice, fruit juice produced as much as 254 mL (39%). Lemon juice produced mechanically sterilized (filtration), using a small pore filter (0.2 μm - 0.45 μm), to filter out pathogens. Results of ascorbic acid content measurement samples lemon juice titration method iodimetric obtained at 44.44 mg / 100 g sample, the levels are smaller than the theoretical level that is equal to 53 mg / 100 g. The addition of lemon juice will affect the final pH and increase acidity in soy yogurt products.

![Figure 1](image1.png)

**FIGURE 1.** The reaction of L-ascorbic acid with a free radical DPPH.

![Figure 2](image2.png)

**FIGURE 2.** Graph antioxidant activity of soy yogurt before and after fortification lemon juice

From Figure 2 it is known that the addition of lemon juice can increase antioxidant activity, and the highest value obtained on L2. In the soy yogurt before the lemon juice fortified soy yogurt control (L0) has antioxidant activity of 40.04%. The presence of the antioxidant activity of the product L0 due to the base material in the form of soy yogurt contains flavonoids and lactic acid formation and activity of probiotic bacteria produce compounds that can act as antioxidants.

Increased antioxidant activity occurred in soy yogurt fortified lemon juice after which the product L1, L2 and L3 respectively 77.13%, 93.88% and 88.97%. DPPH solution color change from purple to a yellow color, due to the donation of hydrogen atoms on the
unpaired electrons from the group N in the structure of DPPH. The stronger the antioxidant activity, the decline in the greater intensity of the purple color so that the resulting yellow color deepened.

Results of Sensory Analysis

The results of sensory test by hedonic rating by a 25 untrained panelists, on the parameters of color, smell, flavor and texture for each sample of soy yogurt is shown in Figure 3:

![Graph A panelist on color, smell, flavor, and texture of the yogurt.](image)

In the color parameters, the average panelists preferred the L1 product that is soy yogurt with a variety of 9:1, followed by the product L0, L2 and L3. Average panelists liked the fourth color samples of soy yogurt. The more the addition of lemon juice causes the color of soy yogurt approaching a yellowish white color.

In the smell parameters, sequence preference level panelists namely L3 > L2 > L1 > L0. L3 product chosen as the product of the most preferred by the panelists as L3 product has a fresh smell and smell of rotten soybeans lost. Lemon juice is added can improve the smell of soy yogurt. This is similar expressed by Cahyadi, that fruit juices can eliminate unpleasant odors caused by the base material is soy milk yogurt.

In the flavor parameters, the average panelists preferred the L1 product that is soy yogurt with a variety of 9:1, followed by soy yogurt products, namely L0 control. This is due to the increasing number of lemon is added to the product L2 and L3 cause more acidic flavor of soy yogurt.

In the texture parameters, the average penelis like L1 products namely soy yogurt with a variety of 9:1, followed by soy yogurt products, namely L0 control. This is due to the increasing number of lemon is added to the product L2 and L3 cause more watery product texture.

From the results of sensory analysis, the fortified soy yogurt lemon juice most panelists favored by parameter smell is yogurt L3 (7:3), while for the taste, texture and color of the panelists preferred the yogurt product L1 (9:1).

CONCLUSIONS
The antioxidant activity in lemon juice is 98.32%. Yogurt soy after fortification lemon juice with the highest antioxidant levels is L2 (ratio yogurt: lemon juice = 8: 2), is 93.88%. While yogurt L1 (9: 1) adalah 77.13%, and L3 (7: 3) is 88.97%. The yogurt before fortification with antioxidant levels of 40.04%. Soy yogurt after fortification has antioxidant activity greater than the antioxidant activity of yogurt before fortification lemon juice. The results of the analysis of the best preferred sensory panelists based parameters namely yogurt smell L3 (7: 3), while for the color, flavor and texture of the panelists preferred the yogurt L1 (9: 1).

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INVESTIGATION OF THE COMPLEXATION OF THE CATECHOL FUNCTION WITH ALUMINIUM (III) BY MOLECULAR SPECTROSCOPY AND MODELLING

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INTRODUCTION

The aluminum quantitatively the 3rd element of the earth’s crust, is present in natural waters, soils and sediments in different forms, it may present harmful effects on animals and vegetation. The relative toxicity of Al^{3+} ion can however be modulated by different complex that it can combine with organic compounds. Knowledge of the nature and concentrations of different species obtained solution is first important to understand the chemistry of natural systems and anthropogenic effects on water and soil.

The polyphenolic derivatives, resulting from the degradation of debris and animal Plant (mainly lignin plants) form the structural basis of soil organic compounds (humic and fulvic acids, humin). Ortho-hydroxyl groups of polyphenols are of primary importance in the process of complexing metal ions.

In this study, the ortho-dihydroxybenzene, commonly called catechol, was chosen because it represents the simplest organic compounds that can modelize this type of complexation, although it is not meeting free state in nature. His drift nitre, 4-Nitrocatechol, presents also the advantage of having lower pKa and possess a...
chromophore (group-NO$_2$), although identifiable spectrometry vibration and sensitive to structural amendments made by the complexation.

We present the current knowledge of polyphenols, catechol and 4-Nitrocatechol and their complexation properties and spectroscopic study (UV-visible absorption and Raman scattering) and structural 4-Nitrocatechol. This study versus pH has allowed us to obtain structural and electronic information on the free molecule as well as the mono- and bi-deprotonation forms. The calculation of electronic and vibrational spectra, using quantum chemistry methods, has facilitated interpretation of experimental results.

A study of the complexation of Al$^{3+}$ ion by catechol and 4-Nitrocatechol by spectrometric of UV-visible absorption is presented in this research. To supplement the previous studies, the chelating behavior of the catechol function and stoichiometry of the complexes are studied taking into account the type of solvent and acid-basic conditions. We investigated the Raman spectra of a complex Al$^{3+}$/4-Nitrocatechol stoichiometry of 1:1 and interpreted on the basis of a study by molecular modeling.

DESCRIPTION OF EQUIPMENT AND EXPERIMENTAL CONDITIONS

Catechol and 4-Nitrocatechol products are distributed by the company Lancaster. To study the reaction of complexation of various compounds using the method of mole ratio, we prepare stock solutions of catechol and 4-Nitrocatechol at concentrations of 10$^{-3}$ mol L$^{-1}$ in the appropriate solvent (pure methanol mixture methanol-water, aqueous solution of acetic acid or Tris). Similarly solutions of mothers anhydrous AlCl$_3$ or AlCl$_3$·6H$_2$O have been prepared in a concentration range of 10$^{-3}$ mol L$^{-1}$-10$^{-2}$ mol L$^{-1}$.

The UV-visible absorption spectra of these solutions were recorded after a delay of about 24 hours in darkness, so that the equilibrium is reached. Raman scattering spectra of 4-Nitrocatechol complexed with Al (III) were recorded with a Horiba-Dilor spectrometer (Labram) team of confocal microscope OLYMPUS BX 40 and a Helium-Neon laser source emitting a wavelength 632.8 nm. Each spectrum obtained on the range 200-1850 nm with an average of 10 successive acquisitions whose integration time of 60 seconds has been fixed. The acquisition and data processing were carried out from the Labspec software. The samples analyzes contained in 4 mm diameter glass tubes are placed under a microscope objective X 10.

The geometry optimization of calculations were performed at the insulated molecule using the semi-empirical method AM1 was using the HyperChem official trade (Version 5.0) and a method BPW91 DFT / 6-31G (d, p ) available under version GAUSSIAN 94 set on the MUST of studies and Research center Lasers and Applications Research (CERLA, LILLE 1). The choice of method AM1 was mainly motivated by the fact that the base is used for the study of systems involving links within or between molecular hydrogen [Dannenberg (1992) and Vrielynck (1996)]. While BPW91 method in the case of DFT calculations was due selects already realized successful work on the molecule catechol [Gerhard S, and Mr. Schumm, S (1998)].

RESULTS AND DISCUSSION

Soil organic matter, which is of first importance in crop fertilization and environmental problems, results principally the biodegradation of vegetable matter, mainly lignin. It is naturally rich in derivatives and some polyphenolic presenting molecules identical to those group meetings in the lignin molecules can be considered as models. Catechol is considered the simplest models of humic substances [Goh, KM (1971) because it is one of the main functional group involved in the metal complexation process in the soil organic matter [Martin, JP (1977)].
The addition of an increasing amount of AlCl$_3$ a catechol solution in methanol causes a bathochromic displacement of the band situated 277 nm, a result of the appearance of the new complex absorption band ($\lambda_{\text{max}}$ = 286 nm) which gradually increases with the amount of Al (III) present in the solution (Fig. 1a). The presence of an isosbestic point a 276 nm indicates the presence of a balance between two species: free and catechol complex. In this environment, so there is the formation of a single complex.

The graph representing the variation in absorbance at 286 nm ($\lambda_{\text{max}}$ complex) according to the molar ratios [AlCl$_3$] / [cat] is presented in Figure 1b. The tangent at the origin and the right corresponding to constant values of the absorbance values high molar ratios intersect has a value [AlCl$_3$]/[cat] = 1. This means that the stoichiometry of the complex is 1:1.

Robert, CH et al (1981) studied by Mossbauer spectroscopy, catechol complexation with iron in water. Depending on the pH, catechol form with iron complexes of various stoichiometries:
- 3.0<pH<4.0 (Green Complex) Fe (III): Cat = 1: 1
- 4.5 <pH <6.5 (blue complex)Fe (III): Cat = 1: 3
- 6.5 <pH <9 (purple complex) Fe (III): Cat = 1: 2

The addition of increasing amounts of AlCl$_3$ has 4-Nitrocatechol in methanol solution causes a decrease of intensity of the band is 343 nm and the appearance of a new band 396 nm the absorbance increased with the amontaluminum (III)−added (Fig.2a). All spectra of the network pass through three isosbestic point at 362 nm, 277 nm and 250nm indicating the formation of a unique complex. The stoichiometry of the complex shape is determined by drawing the curves of absorbance at different wavelengths(absorption maxima of the complex 396 nm and the freemolecule: 343 nm) as a function of the molar ratios. For both curves, the tangent at the origin and the corresponding right to the constant absorbance values intersect at molar ratio [AlCl$_3$] / [4-nct= 1. The stoichiometry of the complex shape is thus 1: 1 (Fig.2b). Thus in methanol, catechol and 4-Nitrocatechol form any two a 1: 1 complex with Al (III).
The addition of an increasing amount AlCl3 has a 4-Nitrocatechol solution dissolved in a mixture methanol (90%) and water (10%), causes a decrease in band 1 to 345 nm relative to the free molecule and a new 406 nm band appears (Fig. 3a). The spectra form has isosbestic three points 367, 278 nm and 251 nm still indicating the formation of a unique complex as in the previous case.

The absorbance variation curvewas 406 nm according to the ratio[AlCl₃]/[4-ncat]indicates a stoichiometry 1: 1(Fig. 3b). The complex form is the type[Al(4-ncat)]⁺.

Measurements carried out with the mixed solvent (methanol - water) increasingly rich in water show that the stoichiometry of the complex shape is not modified by the presence of water. However, the use of aluminum chloride must considerably change the pH as a measure of the additions is why the pH of the aqueous fraction-added mixed these solutions must be controlled. In a Primier time we were interested in the influence that could have the pH on the stoichiometry of the complex forms between the 4-Nitrocatechol and aluminum. A way of controlling the initial state of protonation of 4-molekul Nitrocatechol in methanol mixtures (90%) - water (10%), the pH of the aqueous fraction added to methanol was adjusted. However, although buffered, there is a slight decrease in pH of the solution during the addition of aluminum chloride (pH about 0.3 units). In an acid medium (pH = 2.5) in methanol mixture (90) -water (10%), the reaction of complexation between the 4-Nitrocatechol and aluminum (III) is very difficult. Indeed it is necessary to add large amounts of aluminum to complex all the molecules of 4-Nitrocatechol. Only a low intensity band grows to 420 nm, deforming the foot of the
original band. The network spectra (Fig. 4a) presents an isosbestic point a 367 nm indicating the presence of a unique complex. The absorbance variation curve has 417 et was 266 nm according to the ratio \([\text{AlCl}_3] / [4-\text{ncat}]\). Shows that the complex shape is the type Al (III): 4-ncat = 2: 1 rating \([\text{Al}_2(4-\text{ncat})]^{4+}\) (Fig.4b). The model proposed for this chelate is a similar solvato bridge species to that suggested for complex with aluminum forms in alcoholic medium [Boudet, AC (1999)]. It confirms the dimer formation of the aluminum solution in alcohol (Fig.4c).

FIGURE 4. Complexation of 4-Nitrocatechol\((8\times10^{-5}\text{ mol L}^{-1})\) with \(\text{AlCl}_3\) in methanol (90%) - water (10%) in an acid medium \((\text{pH} = 2.5)\) for different ratio \([\text{AlCl}_3] / [4\text{-ncat}]\) (a), Curve corresponding mole ratioof a complexing 4-Nitrocatechol \((8\times10^{-5}\text{ mol L}^{-1})\) with \(\text{AlCl}_3\) in methanol (90%) - water (10%) in an acid medium \((\text{pH} = 2.5)\) plotted for molar ratio \([\text{AlCl}_3] / [4\text{-ncat}]\) between 0-7 (b). Model of the complex \([\text{Al}_2(4\text{-ncat})]^{4+}\) (c).

A more high pH, fixation of aluminum is made easier and type complexes \([\text{Al}(4\text{-ncat})_2]^+\) and \([\text{Al}(4\text{-ncat})_3]^3-\) can form. With a very wide excess of aluminum is toujours the complex \([\text{Al}(4\text{-ncat})]^+\), which becomes majority. It is quite difficult, given our results to draw conclusions about the influence of the solvent in the complexing. Indeed we have seen that a pH acid complexation seems to be easier in a water-alcohol solution of the water, and that more high pH (around pH 4.6) the complex \([\text{Al}(4\text{-ncat})_2]^+\) favors is in aqueous medium at the expense of 1: 1. The determination of the equilibrium constants for each of these experiences could bring us precious complementary information.

Furthermore our study confirms that the chelating power of Al (III) overlooked the 4-Nitrocatechol is higher than that of Zn (II). Indeed; ion Zn \(^{2+}\) complex is not at all in an acidic medium and gives lower stoichiometry of that complex \(\text{Al}^{3+}\) with increasing pH.

To fully characterize the properties of spectrosciques complex in solution or we can observe the overlappingspectra of different forms in the presence, we chose to study the evolution of Raman spectra of mixtures Nitrocatechol aluminum (III) according to the different paremeters who manage the balance.

FIGURE 5. a) The Raman spectra of 4-ncat\((3 \times 10^{-2}\text{ M})\) b) complex with aluminum (III) \([\text{AlCl}_3]/[4\text{-ncat}] =1\) and NaCl (1M) in water pH = 2.17 (c) pH = 2.54 d)pH = 3.08 e) pH = 4.38 (a) The Raman spectra of 4-Nitrocatechol \((3 \times 10^{-2}\text{ M})\) complex with aluminum (III) at constant pH (2.54, a)\([\text{AlCl}_3]/[4\text{-ncat}] = 0\) (b) \([\text{AlCl}_3]/[4\text{-ncat}] = 0.25\) (c) \([\text{AlCl}_3]/[4\text{-ncat}] = 0.5\) (d)\([\text{AlCl}_3]/[4\text{-ncat}] = 1\) (e) \([\text{AlCl}_3]/[4\text{-ncat}] = 2\).
The Raman spectra of 4-Nitrocatechol (3 x 10^{-2} M) in water, alone and with aluminum complex were recorded for different pH values by taking a constant molar ratio [AlCl_3] / [4 -ncat]and equal to 1. They are represented on the Figure 5.a

At a pH of 2.17 very few 4-Nitrocatechol molecules are complexed since the spectrum is very similar new one has free 4-Nitrocatechol, only a few strips of very low intensity has 812 and 1320 cm^{-1} appear. At pH = 2.54, There is a superposition of the spectra of the free and complex forms of 4-Nitrocatechol indicating that complex formation is well begun. Note that from a pH of 3.08, the majority of 4-Nitrocatechol is complex because the intensity band 1341 cm^{-1}, characteristic of the free form of 4-Nitrocatechol, has completely disappeared in favor of the doublet 1320 - 1286 cm^{-1} characteristic of the complex form. In the field of high frequency band 1596 cm^{-1} attributable to the cycle mode (8a) disappears in favor of a single band in 1577 cm^{-1}. This indicates that a ratio

[AlCl_3] / [4 -ncat] = 1, substantially all of the 4-Nitrocatechol is complexed to a pH equal to 3, there is a great similarity of the Raman spectra at pH 3.08 and 4.38 or only the spectrum of the complex shape appears. One can also note the appearance of new lines is 813, 1127, 1233, 1361, and 1427 cm^{-1}, the complex features. The four Raman Specters can notice the complex 4-Nitrocatechol with aluminum constant pH (2.54) for different molar ratios in figure no.5b

Increasing the ratio [AlCl_3] / [4 -ncat] causes a decrease in the relative intensity of the rays attributable to the free form and an increase in the complex features stripes. However, over the report [AlCl_3] / [4 -ncat] = 1, there is no modification of the spectrum and the pH of which seems to be a limiting factor in complexation. Indeed, the Raman spectra corresponding to the molar ratios are 1 and 2 and show a perfectly indentic Specters superimposing free forms and complex.

In a methanol mixture -water, we note that the amount of containing complex is lower because the relative intensity of the line 1341 cm^{-1}, compared to doublet 1319 to 1285 cm^{-1} is more important. It is in the pure methanol that the complexation is most favorable for the band in 1341 cm^{-1} is lower in methanol in a methanol-water mixture.

In the complex shape, a single Al (III) is coordinated to the molecule of 4-Nitrocatechol. The strong disturbance of caractereistique line of the NO_2 group could be interpreted as the consequence of a direct interaction between the metal ion and the rich group doublets not shares. A way of determining whether NO_2 site has any influence on the complexation, we took as the model para - nitrofenol who present as fixing potentiality that the nitro site. The Raman spectra of single para nitrophenol and para nitrophenol in the presence of aluminum in the molar ratio of 1/1 were recorded way to appreciate the complexing power of the nitro group (Fig.6b)

![Figure 6. The Raman spectra of 4-Nitrocatechol(3 x 10^{-2} M) complex with aluminum(III)[AlCl_3]/[4 -ncat]=1,a) in pure methanol. b) in methanol (90%)-water (10%)pH=2.2 c) in methanol (90%)- water (10%)pH = 2.28 (a), Raman spectra of para-nitrophenola ) pH = 4.8. b) and mixtures of para-nitrophenol / Al (III)at pH = 2.8 and c) a pH = 4.6in water.(b) SpectraRaman of 4-Nitrocatechol and b) complex in methanol(c)
The similarity of the Raman spectra of para-nitrophenol in the absence and presence of aluminum shows that no complex is formed under these conditions and therefore proves that NO$_2$ group is not a chelating site metal cation Al$^{3+}$. This shows that the complexation must be envisaged only on catechol group and justifies our choice for molecular modeling.

![Figure 7](image.png)

**FIGURE 7.** Struktur complex [Al (4-Nitrocatechol) 4H$_2$O]$^+$ optimized by the semi-empirical method AM1(a),

atomic numbering used for 4- Nitrocatechol molecule(b)

We optimize molecular structure of the complex formed between the 4-Nitrocatechol and Al (III) by quantum chemical methods (AM1 method). The total charge of the complex is equal to one. The 6-coordination ion Al$^{3+}$ has been complied with by including in our models, 4 solvent molecules H$_2$O or CH$_3$as indicated on the diagram of the complex represented in figure no 7a.

Considering initially the complex [Al (ncat)]$^{n+}$, fixing the ion Al$^{3+}$ on the 4-Nitrocatechol greatly disturbs the structure of the molecule. The benzo ring is undergoing profound changes and loses part of its aromatic character. This gives a decrease in C1-C6 and C2-C3 lengths while others increase from 2 to 3%. Moreover the cycle is not totally plane and $4^0$ of deviation from the plane were calculated. NO$_2$ group is also changing as shown by N-O and C-N lengths and the angles O-N-O and C-N-O. The aluminum ion is located outside the plane of the molecule. The connections C4-O10 and C5-O11 undergo a very marked decrease in their lengths. There is no analogy to observe the structures of forms mono-and bi -deprotonnee[Cornard, J.P. et al,(2005)].All these disturbances are confirmed by DFT calculation that shows similar tendency to Evolution lengths and bond angles and torsion even if the computed absolute values are somewhat different. The only significant difference between the two calculation methods is a rotation of the NO$_2$ group around the liaison C-N ($33^0$) obtained by DFT.

If 4 solvent molecules are positioned around the aluminum to meet the coordination number 6 of metal, the changes noted above are also observed but are nevertheless very attenuated. The cycle remains deformed with the C4-C5 bond (between the two carbons substituted by hydroxyl) longer than the other and a small deviation relative to the flatness that it would adopt a free state. The nature of the introduced supplémentaires ligand does not change the calculations, we get results quite comparable with water molecules and molecules of methanol. One can also notice that the oktaedre formed around the aluminum is not symmetrical, as shown by the O-Al-O-Al angles and distances Al-S.

The design load Mulliken (table n°1) states, in our calculation models, the positive charge is not localized remains on the metal cation but left on the totality of the ligands. In all cases, the burden scope by atom of aluminum is less than 1. This probably explains the significant differences in the structures obtained computed between models with or without additional ligands. This highlights the important role that can have the solvent and the ionic strength of the solution in the structure and stability of the complexes.
In the figure n° 6 c are represented Raman spectra of 4-Nitrocatechol (spectrum a) and 4-Nitrocatechol complex of aluminum (spectrum b) a ratio [AlCl₃] /4-NCAT] = 1.

We have to assist in the interpretation of Raman spectra that computed frequencies by the DFT method to model the non coordinated by solvent molecules. Indeed, the frequencies computed with the method are too high and do not allow to put in evidence the numerous couplings between the vibrators. The frequencies computed and observed experimentally, are listed in table n°2.

The band was situated in 1336 and 785 cm⁻¹ are due to the symmetrical respectively elongation and deformation in the plane of NO₂ group. Apart 7b mode (depending on the rating of wilson), the mode corresponding to the benzene ring have their frequencies disturbed by complexation with aluminum. These frequencies of variation can be explained partly by a change in the geometry of the benzene ring but especially by changes in the couplings. For example, the vibration 8a in the complex, observed at 1572 cm⁻¹, is a mode for while he was a couple OH deformation in the free molecule (band 1591 cm⁻¹). It is the same with NO₂ vibration which couple differently in the molecule and insulated in the complex. The complexation deformed the benzene cycle. It's probably a mechanical binding effect to the change in the length of the C4-C5 bond.

The establishment of a building around octahedral aluminum, tends the distance between O10 and O11 and steric constraint length C4-C5.

**TABLE 1**. Mulliken charges computed with AM1

<table>
<thead>
<tr>
<th></th>
<th>4-ncat</th>
<th>[Al(4ncat)]⁺</th>
<th>[Al(4ncat)]⁺ 4H₂O</th>
<th>[Al(4ncat)]⁺ 4CH₃OH</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO₂</td>
<td>-0.140</td>
<td>-0.029</td>
<td>-0.119</td>
<td>-0.125</td>
</tr>
<tr>
<td>C2</td>
<td>-0.132</td>
<td>-0.082</td>
<td>-0.137</td>
<td>-0.139</td>
</tr>
<tr>
<td>C3</td>
<td>-0.075</td>
<td>-0.058</td>
<td>-0.067</td>
<td>-0.075</td>
</tr>
<tr>
<td>C4</td>
<td>+0.057</td>
<td>+0.074</td>
<td>-0.004</td>
<td>-0.003</td>
</tr>
<tr>
<td>C5</td>
<td>+0.039</td>
<td>+0.111</td>
<td>+0.051</td>
<td>+0.048</td>
</tr>
<tr>
<td>C6</td>
<td>-0.185</td>
<td>-0.130</td>
<td>-0.140</td>
<td>-0.147</td>
</tr>
<tr>
<td>C1</td>
<td>-0.065</td>
<td>-0.016</td>
<td>-0.060</td>
<td>-0.063</td>
</tr>
<tr>
<td>H12</td>
<td>+0.175</td>
<td>+0.217</td>
<td>+0.184</td>
<td>+0.183</td>
</tr>
<tr>
<td>H13</td>
<td>+0.191</td>
<td>+0.225</td>
<td>+0.187</td>
<td>+0.185</td>
</tr>
<tr>
<td>H14</td>
<td>+0.151</td>
<td>+0.207</td>
<td>+0.166</td>
<td>+0.163</td>
</tr>
<tr>
<td>H15</td>
<td>+0.242</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>H16</td>
<td>+0.238</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>O10</td>
<td>-0.237</td>
<td>-0.250</td>
<td>-0.456</td>
<td>-0.468</td>
</tr>
<tr>
<td>O11</td>
<td>-0.259</td>
<td>-0.266</td>
<td>-0.456</td>
<td>-0.449</td>
</tr>
<tr>
<td>Al</td>
<td>-</td>
<td>+0.997</td>
<td>+0.803</td>
<td>+0.806</td>
</tr>
<tr>
<td>H₂O/CH₃OH (1)</td>
<td>-</td>
<td>-</td>
<td>+0.272</td>
<td>+0.297</td>
</tr>
<tr>
<td>H₂O/CH₃OH (2)</td>
<td>-</td>
<td>-</td>
<td>+0.271</td>
<td>+0.271</td>
</tr>
<tr>
<td>H₂O/CH₃OH (3)</td>
<td>-</td>
<td>-</td>
<td>+0.253</td>
<td>+0.269</td>
</tr>
<tr>
<td>H₂O/CH₃OH (4)</td>
<td>-</td>
<td>-</td>
<td>+0.252</td>
<td>+0.247</td>
</tr>
</tbody>
</table>

**TABLE 2**. Frequencies observed and computed by DFT complex 1: 1 in methanol and allocation of normal modes (according to the nomenclature Wilson)

<table>
<thead>
<tr>
<th>Complex [Al (4-nitrocatehol)]</th>
<th>Experimental (cm⁻¹)</th>
<th>Calculated (cm⁻¹)</th>
<th>proposed allocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1572</td>
<td>1562</td>
<td>8a</td>
<td></td>
</tr>
<tr>
<td>1336</td>
<td>1315</td>
<td>` (NO₂), + (C-N)</td>
<td></td>
</tr>
<tr>
<td>1316</td>
<td>1300</td>
<td><code>(NO₂), +</code> (C-O11) + ` (C-H)</td>
<td></td>
</tr>
<tr>
<td>1284</td>
<td>1262</td>
<td><code>(C-O1O) +</code> (C-H)</td>
<td></td>
</tr>
<tr>
<td>1224</td>
<td>1203</td>
<td>` (C-H)</td>
<td></td>
</tr>
<tr>
<td>947</td>
<td>925</td>
<td>7b</td>
<td></td>
</tr>
<tr>
<td>825</td>
<td>864</td>
<td>` (C-H)</td>
<td></td>
</tr>
<tr>
<td>808</td>
<td>820</td>
<td>` (C-H)</td>
<td></td>
</tr>
<tr>
<td>785</td>
<td>788</td>
<td>` (NO₂)</td>
<td></td>
</tr>
</tbody>
</table>
The influence of solvent on the geometry of the edifice is evident on both the formation of the oktaedre around the metal but also through the intermediary of the distribution of loads on the inside of the edifice. The change of the Raman spectrum is more likely caused by the change in the couplings that by modifying the molecular structure of the ligand.

**CONCLUSIONS**

In this work, we are interested in the phenomenon of complexation of the aluminium ion (III) by catechol function. We studied more particularly 4-Nitrocatechol well known for its complexing properties and the possibility of using NO$_2$ as a probe of ligand conformation in Raman spectrometry function.

Our studies of the stoichiometry of the complexes obtained from 4-nitrocatechol and Al$^{3+}$ ion depend on the the solvent and the pH of the solution and are consistent with some results reported in the literature. We were able to evidence, by absorption spectrometry UV-visible the existence of different types of complexes namely [Al$_2$(4-ncat)]$^{4+}$, [Al(4-ncat)$_3$]$^3$, [Al(4-ncat)$_2$]$^1$, [Al(4-ncat)]$^+$, It appears to form a majority for a ratio[Al(III)]/[4-ncat] high. However, in natural environments, it is still controlling the ligand relative to the metal ion, which implies that only the first complex form will be taken into consideration. It could be verified that Zn$^{2+}$ cation is much less than chelate Al$^{3+}$, in fact no complexation could not be observed in an acidic medium. It would be interesting in the future to study the complexation of other metal di-and trivalent (Fe$^{3+}$, Cu$^{2+}$, Pb$^{2+}$) possessing an interest in environmental issues, as well as the competition between the metal species.

It is in the field of spectroscopic studies and molecular modeling calculation that the subject could have the most significant development. The hypothesis that we proposed, namely the mechanical and electronic effects that cause disruption of the cycle, becoming the NO$_2$ group (for which there are ambiguities) and the influence of solvent on the structure of the complex should be confirmed or refuted by new calculations on complex 1:1 and extended to other types of complex.

**ACKNOWLEDGEMENTS**

The work presented in this memories were realized in the infrared and Raman spectrochemistry laboratory. I would like to thank Mr. D. Bougeard, research director at CNRS who had accepted me in LASIR. My gratitude to Mr. Professor J.C. MERLIN, J.P. CORNARD and Laurence Vrielynck the help of guidance and his goodness.

**REFERENCES**

THE ANALYSIS CONTENT OF BISPHENOL A (BPA) ON WATER IN GLASS BEVERAGE PLASTIC WITH TIME-VARYING CONTACTS USING UV-VIS SPECTROPHOTOMETER

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Article info

Abstract
Bisphenol A (BPA) is an additive substance on plastics that is able to stimulate the cancer cells growth and increase the pregnancy risk. The aim of this research is to analyze the BPA content on water that is contained in plastics glass on various contact time using UV-VIS Spectrophotometer. There are 3 samples with the same temperature (800°C) and the same concentration but contact time. The wavelength of spectrophotometer are 200 nm-300 nm. The samples A with 30 minutes contact time have maximum absorbance of 0.625 on 216 nm. The samples B with 15 minutes contact time have maximum absorbance of 0.502 on 218 nm. The samples C with 5 minutes contact time have maximum absorbance of 0.441 on 217 nm. Hence, longer the time contact makes the absorbance higher. It means that by increasing the contact time, the BPA content is increasing.

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INTRODUCTION

Often times, people overlook the importance of health. There are many things that can threaten human health in line with the progress of time. One of those is the possibility of migration of bisphenol A (BPA) in plastic packaging materials to food products. Bisphenol A (BPA) found in plastic polycarbonate (PC) is an additive that can stimulate cancer cells growth and increase the pregnancy risk so that the need was highlighted for further examination to tackle the dangers of BPA.

Many tools have been developed to analyze the content of BPA one of which is a UV-VIS Spectrophotometer. The device works by using the principles of the absorbance of electromagnetic radiation by a material to the wavelength of UV light to visible light. By using a UV-VIS Spectrophotometer, it is possible to accurately detect the content of Bisphenol A (BPA) in the solution. Since BPA can be detected in the wavelength range 200 nm-300 nm which is the area of UV rays.

THEORETICAL BASIS

A. Bisphenol A (BPA)

Humans are very much interacting with the material Bisphenol A (BPA). Its presence in nature allegedly closely associated with an increased incidence of reproductive disorders such as kriptorkhidisme, decreased sperm quality, and an increase in patients with erectile
dysfunction. Polymerization is less perfect than the plastic material during production, or the occurrence of depolymerization due to heating (both intentional and unintentional sterilization purposes during storage) and its derivatives can release BPA into food (4-23 µg / packaging), beverages (7-58 µg / gram), and saliva (90-913 µg / saliva is collected for one hour after the installation of dental sealant), wherein the concentration of effective enough to induce the proliferation of estrogen target cells (such as breast cancer cells) in culture (Novita Harahap, 2009).

Concerns about BPA appeared since reported the possibility of migration of BPA in packaging materials to food products. Factors that influence migration are: surface area contact, the speed of migration, the type of plastic material, temperature and contact time.

B. UV-VIS Spectrophotometer

UV-VIS Spectrophotometer is a tool for analyzing the elements of a low-yield quantitatively and qualitatively by peaks generated in the spectrum of a particular element at a particular wavelength, while the quantitative determination based on the value of the spectrum absorbance resulting complex compounds are analyzed elements. So it can be concluded that the greater number of Bisphenol A (BPA) in the solution, the higher the maximum absorbance.

![Figure 1. Absorption spectra of Bisphenol A (BPA) (The Royal Society of Chemistry, 2009)](image_url)

Lambert-Beer law defines the relationship between the concentration of the sample with the amount of light absorbed by the sample as in equation (1):

\[ A = \varepsilon dC \]  

with:

- \( A \) = Absorbance
- \( \varepsilon \) = constant Absortivitas Molar (\( \text{L.mM}^{-1}.\text{cm}^{-1} \))
- \( d \) = thickness of cuvette (cm)
- \( C \) = Concentration of Samples (\( \text{mM.L}^{-1} \))

**METHOD**

**Tools and Materials :**

The equipments for running the experiments are Shimadzu UV-1800 UV-VIS Spectrophotometer; computers; 1 digital balance unit; 1 set ultrasonicator; 2 units of digital heating devices; 3 units mercury thermometer; 1 unit watches; 1 piece funnel; 1 piece pipette; 1 piece measuring cup 250 mL; 1 piece measuring cup 200 mL; 1 piece measuring cup 100 mL; 1 piece measuring cup 50 ml; 1 piece 100 mL volumetric flask; 1.5 L of distilled water (\( \text{H}_2\text{O} \)); 4 grams of NaOH crystals; 3 pieces of plastic cups with the same brand.

**Procedure Research:**
1. Shimadzu UV-1800 UV-VIS Spectrophotometer is connected to the computer to operate the Shimadzu UV-1800 UV-VIS Spectrophotometer.
2. Open the UV Probe software program on the computer.
3. Measured 4 grams NaOH crystals on a digital balance by incorporating crystals NaOH into a measuring cup 50 ml NaOH crystals are then given 20 mL H₂O after it is put in Ultrasonicator NaOH to dissolve crystals.

4. Created 1 N NaOH solution preheated 40° C: 20 mL solution of NaOH put into a 100 mL volumetric flask then added 80 mL H₂O using a funnel to mark boundaries. After it is inserted into a measuring cup and heated to 250 mL with digital heating until the solution temperature of 40° C measured by a mercury thermometer.

5. Made sample solution
   a. Sample A
      Put 110 ml of distilled water (H₂O) into a 200 ml graduated cylinder is then heated with digital heating to a temperature of 80° C as measured by a mercury thermometer. After the distilled water (H₂O) preheated 80° C is inserted into a plastic cup for 30 minutes with keeping the temperature, then taken 90 mL H₂O which have been put on the glasses A and put in a 100 ml measuring cup and mixed with 10 mL of 1 N NaOH solution 40° C temperature, in order to obtain NaOH solution with a concentration of 10 % at a temperature of 76° C.
   b. Sample B
      Put 110 ml of distilled water (H₂O) into a 200 ml graduated cylinder is then heated with digital heating to a temperature of 80° C as measured by a mercury thermometer. After the distilled water (H₂O) preheated 80° C is inserted into a plastic cup B for 15 minutes with keeping the temperature, then taken 90 mL H₂O which have been put on the glasses B and put into the measuring cup 100 ml and mixed with 10 mL of 1 N NaOH solution 40° C temperature, in order to obtain NaOH solution with a concentration of 10 % at a temperature of 76° C.
   c. Sample C
      Put 110 ml of distilled water (H₂O) into a 200 ml graduated cylinder is then heated with digital heating to a temperature of 80° C as measured by a mercury thermometer. After the distilled water (H₂O) preheated 80° C is inserted into a plastic cup C for 5 minutes with keeping the temperature, then taken 90 mL H₂O which have been put on the glasses C and put in a 100 ml measuring cup and mixed with 10 mL of 1 N NaOH solution 40° C temperature, in order to obtain NaOH solution with a concentration of 10 % at a temperature of 76° C.

6. Once opened UV Probe Software on points 2 and then click connect-> Spectrume -> Methods (filled in the wavelength range to be studied) -> A blank is inserted (H₂O + NaOH solution 1:9) without treatment -> Baseline-> Auto Zero.

7. Pipette solution Samples A, B, and C in turn into the cuvette in a Shimadzu UV-1800 UV-VIS Spectrophotometer.

8. It starts reading the sample solution A, B, and C by clicking start to operate the Shimadzu UV-1800 UV-VIS Spectrophotometer

**RESULTS AND DISCUSSION**

Analysis of Bisphenol A in plastic beverage cups of water with a contact time varied using UV-VIS Spectrophotometer obtained the data as in Figure 3, Figure 4 and Figure 5.
(a) (b) (c)

**Figure 2.** Research Tools (a) Ultrasonicator to destroy the crystal NaOH. (b) Digital heating to make the sample A, B, and C. (C) The operation of the Shimadzu UV-1800 UV-VIS Spectrophotometer

![Figure 2](image)

**Figure 3.** Absorption Spectra of Bisphenol A (BPA) sample A

![Figure 3](image)

**Figure 4.** Absorption Spectra of Bisphenol A (BPA) Sample B

![Figure 4](image)

**Figure 5.** Absorption Spectra of Bisphenol A (BPA) sample C

![Figure 5](image)

From Figure 3, Figure 4 and Figure 5, the compiled data is shown in table 1:

<table>
<thead>
<tr>
<th>No</th>
<th>Sample</th>
<th>Contact Time (minute)</th>
<th>Absorbance Maximum</th>
<th>Maximum wavelength (nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>30</td>
<td>0.625</td>
<td>216</td>
</tr>
<tr>
<td>2</td>
<td>B</td>
<td>15</td>
<td>0.502</td>
<td>218</td>
</tr>
<tr>
<td>3</td>
<td>C</td>
<td>5</td>
<td>0.441</td>
<td>217</td>
</tr>
</tbody>
</table>

As indicated in Table 1 that each sample has a different maximum wavelength is at the wavelength $(217 \pm 1)$ nm. Since it has the highest absorbance wavelength.
The provision of contact time variation obtained different absorbance. The higher contact time, the higher the absorbance. It can be interpreted that with the increasing contact time of foodstuffs such as water to the container is made of plastic material, the higher the concentration of bisphenol A (BPA) that migrate in foodstuffs.

Figure 6 shows the relationship between the contact time to the absorbance.

![Figure 6. The Relationship Between The Contact Time to The Absorbance](image)

**CONCLUSION**

The experiments that have been done is to provide a contact time variation of water temperature of 80°C at 3 samples of similar plastic beverage cups using UV-VIS Spectrophotometer with the intensity of a wavelength of 200 nm-300 nm, it showed that the sample A contact time of 30 minutes with a maximum absorbance 0.625 at a wavelength of 216 nm, the sample B within 15 minutes with a maximum absorbance of 0.502 at a wavelength of 218 nm, the sample C contact time of 5 minutes with a maximum absorbance of 0.441 at a wavelength of 217 nm. It can be concluded that the higher contact time, the higher the absorbance, which means the increasing contact time, the more the content of Bisphenol A (BPA) in the sample.

**REFERENCES**

INTRODUCTION

Indonesia has many species of plants that have the potential to produce a cincau gel. However, there are three popular plants commonly utilized by Indonesian people as a producer of cincau, namely Premna oblongifolia Merr or cincau perdu, Cyclea barbata Miers or cincau rambat, and Mesona palustris, known by the public in some areas as janggelan, producer of black cincau. Two first-mentioned plant is green cincau producer. As the food, cincau has many health benefits (Femina, 2014).

Green cincau (Premna oblongifolia Merr) is a traditional food ingredient that has long been known to the public and used as beverage contents. The green cincau liked by the people because the taste typical, fresh, chilled, and the price is cheap.

Green cincau extract is composed of the main components of pectin polysaccharide substances that form a gel in cincau. The content of pectin polysaccharide found in green cincau is a hydrocolloid gelling group.

Roiyana (2012) suggests that the content of hydrocolloid on green cincau gel could potentially be used as an edible film on delay of ripening tomatoes. However, in terms of the appearance of green cincau gel can affect the selling value will be lower compared to fruit that is coated with gel seaweed because it was colorless and transparent. In addition as foodstuffs, green cincau gel can be used as a binder in tablet antacid, replacing CMC.
(Carboxy Methyl Cellulose) were white. But the color and thickness uniformity of antacid tablets obtained have not qualified (Muchtaridi, 2009). Therefore, efforts should be made to reduce the intensity of the green color of green cincau gel.

The chlorophyll contained in the green cincau which is colored green pigment that gives color to the leaves. One way to adsorb the color component can be done by using an adsorbent. In this study the adsorbent will be used is bentonite, bamboo charcoal and mixture of both.

Bentonite is a type of smectite minerals composed of alumino silicate skeleton, forming a layered structure and a good cation exchanger. The main content of the bentonite is montmorillonite. Montmorillonite causes the very large surface area about 700-800 m²/g. Bentonite has high ability to expand so that it can adsorb organic compounds and metal ion (Ashadi in Nurhayati, 2010).

Using acid activation will produce bentonite with active sites larger and larger surface acidity, that will produce bentonite with higher adsorption capacity than before activated (Komadel, 2003).

Bamboo charcoal is a solid product (solid) which uses bamboo raw materials (can be from raw material valley) through the carbonisation process under high temperature. As adsorbent, activated charcoal prior to enlarge the active surface area by opening the pores are covered by tar and free atoms. Activators commonly used for the manufacture of activated charcoal with chemical activation is KOH, ZnCl₂ and H₃PO₄.

Activated charcoal or bentonite can be used as adsorbents to adsorb organic molecules. Therefore, in this study used bamboo charcoal (Gigantochloa verticillata) and bentonite to adsorb chlorophyll of green cincau extract.

METHOD

Materials
This study used a sample of green cincau leaves from Padalarang. The materials needed are gombong bamboo charcoal from Ciparay Bandung, H₃PO₄, HCl 5 N, bentonite, technical methanol, distilled water, spectrometer Uvmini-1240, FTIR, GCMS and SEM.

Sample preparation
Green cincau leaves was cleaned from dust and parts that are not needed. Then separated from the stalks and cleaned and weighed.

Green Cincau Leaves Extraction Extraction with water
Green cincau leaves about 8 grams extracted using 400 ml of water with squeezing, then filtered using a filter cloth. Fitrat obtained is an extract of green cincau leaf.

Extraction with methanol
Green cincau leaves about 20 grams was crushed with blender using 50 ml of methanol for 3 minutes. Crushed then filtered with smooth filter cloth, and then the filtrate obtained is filtered again with Buchner funnel using filter paper. Filtering use a vacuum pump. The residue was washed with 50 ml of methanol and then filtered again with Buchner funnel (Alsuhendra in Nurdin, 2009).

Adsorbent Preparation
1. Activation of Bamboo Charcoal
Bamboo charcoal obtained from the carbonization, pulverized using mortar and pestle. Then soaked in H₃PO₄ solution 5%, 10% and 15% for 24 hours. The pasta is heated in a furnace at 700°C for 1 hour. Activated charcoal was cooled and washed with distilled water until neutral and then dried at 110°C for ±8 hours.

2. Activation of Bentonite
Natural bentonite was soaked in 5 N HCl solution and then heated at 70°C while stirring. The pasta was settle for one night. Then washed with hot water until the washing water pH ≥ 3 and dried at ±100°C until its weight constant.

**SEM Analysis**
Activated charcoal and bentonite was analyzed with SEM to determine the pore structure of the adsorbent. Analyses were performed at the Laboratory of Geological Survey Center Bandung.

**The Effect of Adsorbent Addition into Greeen Cincau Extract**

The addition of the adsorbent carried in variety of mass ratio between activated charcoal with bentonite. Then the separation of the adsorbent from green cincau extracts. The filtrate were measured its absorbance using spectrometer UV/Vis and its components compounds were analyzed using GCMS, while the residue obtained examined using FTIR spectrometer and SEM analysis.

**Optimation of Adsorbent Mass Ratio**

Green cincau extract about 10 grams was contacted with variety of mass ratio between activated charcoal and bentonite (1: 0, 1: 3, 1: 2, 1: 1, 2: 1, 3: 1, 4: 1, 0: 1) with a total mass 0.5 g for 5 minutes. Results contacting was filtered, and the filtrate absorbance was measured using a spectrometer UV/Vis at wavelength of chlorophyll (664.5 nm).

**Optimation of Adsorbent Mix Concentration (Bamboo Charcoal+Bentonite)**

Green cincau extract about 10 grams was contacted with variety adsorbent concentration (0-10%) for 5 minutes. Results contacting was filtered, and the filtrate absorbance was measured using spectrometer UV/Vis at wavelength of chlorophyll (664.5 nm).

**Optimation of Contact Time**

Green cincau extract about 10 grams was contacted with variety contact time (5-30 minutes). Results contacting was filtered, and the filtrate absorbance was measured using spectrometer UV/Vis at wavelength of chlorophyll (664.5 nm).

**RESULTS AND DISCUSSION**

**Activation of Bamboo Charcoal**

The activation process of bamboo charcoal is carried out by soaking ±10 g the charcoal in H₃PO₄ solution 5%, 10% and 15% for 24 hours and then activated at 700°C for one hour. Heating results was black powder. The addition of different concentrations H₃PO₄ solution not affect the shape and color of activated charcoal. Overall, the results obtained can be seen in Table 1 below:

<table>
<thead>
<tr>
<th>No.</th>
<th>Charcoal mass (g)</th>
<th>[H₃PO₄]</th>
<th>Activated charcoal mass (g)</th>
<th>Randemen (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>10.0165</td>
<td>0%</td>
<td>2.6640</td>
<td>26.4</td>
</tr>
<tr>
<td>2.</td>
<td>10.0874</td>
<td>5%</td>
<td>5.8689</td>
<td>58.2</td>
</tr>
<tr>
<td>3.</td>
<td>10.0092</td>
<td>10%</td>
<td>5.6148</td>
<td>56.1</td>
</tr>
<tr>
<td>4.</td>
<td>10.0166</td>
<td>15%</td>
<td>5.3482</td>
<td>53.4</td>
</tr>
</tbody>
</table>

From the data above shows that the mass reduction occurs during the activation process. The data shows the evaporation of volatile compounds from the raw materials. The mass loss after this activation process also shows the reaction between activator with charcoal to produce activated charcoal by more pores. The activation of charcoal using heating (H₃PO₄ 0%) resulted slightly randemen activated charcoal and based on
observations there are a lot of ash. This is because $H_3PO_4$ able to reduce reaction rate in the oxidation process between carbon with water vapor to produce CO or CO$_2$.

To get a more pure activated charcoal then washing by distilled water. This is because there is still residual unreacted H3PO4. Washing process is done repeatedly until neutral.

**Adsorption Test of Activated Charcoal**

Analysing the adsorption capacity of activated charcoal by contacting the activated charcoal with green *cincau* extract. The mixture is filtered and measured the absorbance of extract at maximum wavelength of chlorophyll is 664,5 nm. The measurement results from the data is shown in Table 2:

**TABLE 2. Efficiency of Activated Charcoal Adsorption on Chlorophyll**

<table>
<thead>
<tr>
<th>No.</th>
<th>Type of activated charcoal</th>
<th>Color of extract</th>
<th>Absorbance</th>
<th>Efficiency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Control</td>
<td>Green</td>
<td>0,5739</td>
<td>-</td>
</tr>
<tr>
<td>2.</td>
<td>Before activated</td>
<td>Green light</td>
<td>0,5333</td>
<td>7,07</td>
</tr>
<tr>
<td>3.</td>
<td>$H_3PO_4$ 0% activation</td>
<td>Green light</td>
<td>0,0865</td>
<td>84,9</td>
</tr>
<tr>
<td>4.</td>
<td>$H_3PO_4$ 5% activation</td>
<td>Colorless</td>
<td>0,0227</td>
<td>96,0</td>
</tr>
<tr>
<td>5.</td>
<td>$H_3PO_4$ 10% activation</td>
<td>Colorless</td>
<td>0,0244</td>
<td>95,7</td>
</tr>
<tr>
<td>6.</td>
<td>$H_3PO_4$ 15% activation</td>
<td>Colorless</td>
<td>0,0273</td>
<td>95,3</td>
</tr>
</tbody>
</table>

From the data shows that there is decrease of absorbance value after the extract is contacted with activated charcoal. Activated charcoal, which is activated using $H_3PO_4$ 0% (with heating) has the lowest efficiency in adsorbing chlorophyll than any other active charcoal is indicated by high absorbance value. While activated charcoal with 5% $H_3PO_4$ has the highest efficiency. Increasing concentrations of $H_3PO_4$ up to 5% can increase the adsorption of active charcoal to chlorophyll, but then decreased at concentrations > 5%. It shows the activation of charcoal using 5% $H_3PO_4$ has optimum adsorption capacity to adsorb the chlorophyll.

**SEM Analysis Results**

The influence of $H_3PO_4$ concentration on the pore structure of activated charcoal is analyzed using SEM (Scanning Electron Microscope). There is SEM analysis results:

![Charcoal Before Activated](Charcoal_Before_Activated)
![$H_3PO_4$ 0% Activation](H3PO4_0%_Activation)
![$H_3PO_4$ 5% Activation](H3PO4_5%_Activation)
![$H_3PO_4$ 10% Activation](H3PO4_10%_Activation)
![$H_3PO_4$ 15% Activation](H3PO4_15%_Activation)

**FIGURE 1. Activated Charcoal Pore Structure**

Based on the above pictures, found that the pores of charcoal before activated has not been opened. Activation charcoal using heating at 700°C ($H_3PO_4$ 0%) has opened the
pores so that the charcoal can adsorb chlorophyll. The addition of H$_3$PO$_4$ effect on activated charcoal pores formed. The higher concentration of H$_3$PO$_4$, has pore diameter >10μm more. Based on an analysis using a spectrometer UV/Vis, activated charcoal adsorption ability which activated using H$_3$PO$_4$> 5% was decline slightly. This is because the concentration of H$_3$PO$_4$ >5% are formed pores with diameters >10μm more, and affect to decreased adsorption ability. This is consistent with the theory that the pore structure related to the surface area, the larger pores of activated charcoal will cause the smaller surface area then resulting in decreased adsorption ability. In addition, it is possible that the activation using H$_3$PO$_4$ 5%, the pores according to the size of the chlorophyll molecule as adsorbate.

**Activation of Bentonite**

Bentonite (100 g) is light brown powder and activated using 5N HCl with heating temperature 70°C. Bentonite activation was pulverized to expand its surface so can increase the adsorption capacity of bentonite in adsorbing the color of green *cincau* extract. Activated bentonite obtained 72,7 grams with the light brown powder (do not change color during the activation process). Activated bentonite was analyzed to see the bentonite pores by SEM. SEM analysis result of active bentonite can be seen in **Figure 2** below.

![FIGURE 2. Pore Structure of Active Bentonite](image)

Based on the above picture, it can be seen that the pore of active bentonite did not open. This shows that the activation process is not optimal.

**Optimation Adsorbent Mass Ratio**

Optimation was done by taking 10 mL green *cincau* extract then it is contacted with a variety mass ratio of activated charcoal with active bentonite. The total mass of adsorbent ± 0,5 grams. Absorbance of green *cincau* extract which has been contacted with an adsorbent was measured using spectrometer UV/Vis at wavelength of 664,5 nm. Overall results obtained from the data in **Table 3** below.

<table>
<thead>
<tr>
<th>No.</th>
<th>Bamboo charcoal : bentonite</th>
<th>Absorbance</th>
<th>Efficiency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Control</td>
<td>0.549</td>
<td>-</td>
</tr>
<tr>
<td>2.</td>
<td>0:1</td>
<td>0.236</td>
<td>57.01</td>
</tr>
<tr>
<td>3.</td>
<td>1:3</td>
<td>0.031</td>
<td>94.35</td>
</tr>
<tr>
<td>4.</td>
<td>1:2</td>
<td>0.030</td>
<td>94.54</td>
</tr>
<tr>
<td>5.</td>
<td>1:1</td>
<td>0.028</td>
<td>94.90</td>
</tr>
<tr>
<td>6.</td>
<td>2:1</td>
<td>0.029</td>
<td>94.72</td>
</tr>
<tr>
<td>7.</td>
<td>3:1</td>
<td>0.027</td>
<td>95.08</td>
</tr>
<tr>
<td>8.</td>
<td>4:1</td>
<td>0.050</td>
<td>90.89</td>
</tr>
<tr>
<td>9.</td>
<td>1:0</td>
<td>0.017</td>
<td>96.90</td>
</tr>
</tbody>
</table>

Based on the data it can be seen that by mixing the adsorbent with higher concentration of activated charcoal can decline the absorbance value of the extract. To determine the effect of activated charcoal to extract absorbance values can be seen in **Graph 1** below.
From the chart shows that the addition of activated charcoal up to 75% can reduce the value of absorbance green cincau extract, but the addition of a concentration 80% can increase the absorbance value. So that the optimum concentration of activated charcoal used was 75%, on mixing activated charcoal adsorbent with bentonite is 3: 1. But the absorbance values is greater than the absorbance value extract which contacted with activated charcoal alone.

Absorbance value of green cincau extract which contacted with activated charcoal were lower compared to mixture of both bentonite and activated charcoal. So the activated charcoal has the highest adsorption ability to adsorb the chlorophyll. But economically, activated charcoal has more expensive price than the bentonite. Therefore, to minimize the cost of production can be performed using activated charcoal mixture with bentonite. Based on the absorbance values obtained in Table 3 absorbance values with activated charcoal and bentonite ratio of 3: 1 has the lowest absorbance value compared with other comparative and absorbance values obtained are not too much different from the absorbance value of the extract is contacted with activated charcoal alone. In addition, the gel is formed after the extract is contacted with mixture of bentonite and activated charcoal and activated charcoal alone has the same physical properties. Therefore, in future studies used adsorbent activated charcoal and bentonite mixture with a ratio is 3: 1.

**Optimation of Adsorbent Concentration**

Optimation is done with various concentrations of the adsorbent. The adsorbent used is activated charcoal: bentonite (3: 1).

Data of the absorbance values with variation adsorbent concentration is presented in Graph 2 below.
Based on the chart it can be seen that the addition of 2% adsorbent can reduce the value of the absorbance extract significantly, but the addition of 3-10% extract absorbance values are not significantly reduced. Therefore, the addition of the adsorbent is then performed experiments with concentrations between 0-2%. Overall results obtained from the data in Graph 3 below.

The graph above shows that the greater of adsorbent concentration is added then the absorbance value of extract decreases, that means more chlorophyll is adsorbed by the adsorbent. But after the adsorbent concentration 1,5% the absorbance value is increase. This shows that the optimum adsorbent concentration is at 1,5% adsorbent.

**Optimization of Contact Time**

Optimization is done with a variety of contact time (5-30 minutes). Data of absorbance values with variations contact time presented in Graph 4 below.
Based on the graph above shows that contacting the adsorbent with green *cincau* extract for 5-10 minutes extract decreased the absorbance value means more chlorophyll is adsorbed by the adsorbent, but on contacting more than 10 minutes absorbance values obtained increasing. So that the optimum contact time on bleaching the green *cincau* extract is 10 minutes.

**FTIR Analysis Result of Adsorbent Before and After Contact**

Infrared spectra of adsorbent before and after contact with green *cincau* extract is shown in Figure 3 below.

![Infrared spectra of adsorbent before and after contact](image)

**TABLE 1. Prediction Functional Groups of Adsorbent**

<table>
<thead>
<tr>
<th>Wave numbers (cm⁻¹)</th>
<th>Before contact</th>
<th>After contact</th>
<th>Prediction functional groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>468.7</td>
<td>468.7</td>
<td>Si-O-Si</td>
<td></td>
</tr>
<tr>
<td>524.6</td>
<td>524.6</td>
<td>Si-O</td>
<td></td>
</tr>
<tr>
<td>677.0</td>
<td>677.0</td>
<td>C-H alkenes, C-H aromatic</td>
<td></td>
</tr>
<tr>
<td>711.7</td>
<td>709.8</td>
<td>C-H alkenes, C-H aromatic</td>
<td></td>
</tr>
<tr>
<td>754.1</td>
<td>754.1</td>
<td>C-H alkenes, C-H aromatic</td>
<td></td>
</tr>
<tr>
<td>792.7</td>
<td>794.6</td>
<td>Si-O</td>
<td></td>
</tr>
<tr>
<td>1041.5</td>
<td>1041.5</td>
<td>C-O ester</td>
<td></td>
</tr>
<tr>
<td>1103.2</td>
<td>1103.2</td>
<td>C-O ester</td>
<td></td>
</tr>
<tr>
<td>1136.0</td>
<td>1134.1</td>
<td>C-O ester</td>
<td></td>
</tr>
<tr>
<td>1186.1</td>
<td>1186.1</td>
<td>C=O</td>
<td></td>
</tr>
<tr>
<td>1579.6</td>
<td>1579.6</td>
<td>C=O</td>
<td></td>
</tr>
<tr>
<td>1720.4</td>
<td>1720.4</td>
<td>C=O</td>
<td></td>
</tr>
<tr>
<td>2852.5</td>
<td>2852.5</td>
<td>C-H alkane</td>
<td></td>
</tr>
<tr>
<td>2920.0</td>
<td>2920.0</td>
<td>C-H alkane</td>
<td></td>
</tr>
<tr>
<td>3423.4</td>
<td>3423.4</td>
<td>O-H</td>
<td></td>
</tr>
</tbody>
</table>

Based on the data above, functional groups that allegedly contained in the adsorbent before and after contact with the green *cincau* extract does not give a significant difference indicated by the value of the wave number is almost the same, but the decreased value of% transmittance indicates an increase in intensity due to increasing quantities functional groups. Increasing the quantity of functional groups can be caused by the presence of chlorophyll which is adsorbed by the adsorbent.

**SEM Analysis Result of Adsorbent Before and After Contact**

SEM analysis results can be seen in Figure 4 and Figure 5 below.
Based on the pictures above it can be seen that the adsorbent before and after use to adsorb green *cincau* extract did not change significantly (adsorbent pores are still open) so the adsorbent which has been contacted with green *cincau* extract is expected to be used as an adsorbent for the next adsorption, but will have low adsorption ability.

**GCMS Analysis of Green *Cincau* Extract Before and After Contact**

Green *cincau* extract that has been contacted with an adsorbent, analyzed using GCMS, but the results of the analysis indicate that the compounds contained in extracts of green *cincau* extract before and after contacted with an adsorbent is not detected by GCMS.

**CONCLUSIONS**

The optimum conditions of contacting the adsorbent with green *cincau* extract is at concentration of adsorbent is 1,5% with activated charcoal and bentonite ratio of 3: 1 and 10 minutes contact time. Based on the FTIR analysis, the adsorbent which has been contacted not changes chemically and based on SEM analysis of adsorbent which has been contacted with green *cincau* extract has pores that are still open, meaning that they can be used for the next adsorption. While the green grass *cincau* extract before and after contacted with an adsorbent can’t be detected by GCMS.

**ACKNOWLEDGMENTS**

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**REFERENCES**


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INTRODUCTION

There are several instruments to measure the academic achievement of students in chemistry teaching and learning, such as multiple choices question, true-false question, etc. These kinds of this instruments can be categorized in two models, which are paper based question and computer based question.

Multiple choices question is one form of evaluation that the answer can be obtained by selecting one of the answers that have been provided. This kind of evaluation consists of two parts, which are a problem (stem) and a list of suggested solutions (alternatives)\cite{1}. The basic form of a stem is a question or an incomplete statement. Moreover, the list of the alternatives contains of the best answer (or the correct answer) and a number of incorrect answer or inferior alternatives (distractor).

Multiple choices question can be used to measure various levels of cognitive knowledge, which are related to Bloom’s taxonomy of educational objectives (knowledge, comprehension, application, analysis, synthesis, and evaluation). The strengths of this type question\cite{2}:
1. Learning outcomes from simple to complex can be measured.
2. Highly structured and clear tasks are provided.
3. A broad sample of achievement can be measured.
4. Incorrect alternatives provide diagnostic information.
5. Scores are more reliable than subjectively scored item (e.g. essay).
6. Scoring is easy, objective, and reliable.
7. Item analysis can reveal how difficult each item was and how well it discriminated between the strong and weaker student in the class.
8. Performance can be compared from class to class and year to year.
9. Can cover a lot of material very efficiently.

As an instrument for evaluation, this model has limitations\(^2\), e.g.:
1. Constructing good items is time consuming.
2. It is frequently difficult to find plausible distractors.
3. It is ineffective for measuring some types of problem solving and the ability to organize and express ideas.
4. Scores can be influenced by reading ability.
5. Often focus on testing factual information and fails to test higher level of cognitive thinking.
6. Sometimes there is more than one defensible “correct” answer.
7. Does not provide a measure of writing ability.
8. May encourage guessing.

Usually, multiple choices question have not been able to reveal the chemistry concepts in a comprehensive manner. As a result, students are less able to think constructively and tend to forget the basic chemistry concepts they have learned previously\(^3\). Therefore, it is required a new approach in developing a multiple choices questions.

In this study, the multiple choices questions was developed using systemic approach. Therefore, this type of question is namely systemic multiple choices questions (SMCQs). The systemic approach is an approach in teaching and learning where multiple components are connected to each other by a mutual relationship\(^4\). The alternatives of SMCQs consists of three concepts in chemistry which are connected each other.

This study was developed SMCQs on redox and electrolyte – non electrolyte solution concepts. The aims of this research were (1) to examine the feasibility of the SMCQs, (2) to examine the validity and reliability of the SMCQs, and (3) to analyze the level of difficulty of the SMCQs.

**METHOD**

This kind of this study was a research and development (RnD) that adapted the stages presented by Gall, et al\(^5\), which are:
1. Research analysis, needs assessment, and proof of concept
2. Product planning and design
3. Preliminary product development
4. Preliminary field testing
5. Product revision
6. Main field testing
7. The final product revision

The SMCQs was developed by considering the cognitive level according to Bloom's taxonomy, i.e. remembering, understanding, applying, analyzing, evaluating, and creating\(^6\). Preparation of the test items adjusted to basic competence in chemistry syllabus in Kurikulum 2013.

The instruments of this study were questionnaire and also the SMCQs. Expert judgement conducted on the instrument that have been made. A 15 high school chemistry teachers assessed the quality of SMCQs using questionnaire which consists of three aspects, i.e. construct, structure of the question, and chemistry concept. Each aspect is divided into a number of indicators.
The SMCQs tested to 160 students to determine the validity and reability. The test results are used to determine the level of difficulty of the SMCQs. The data was analysis using Winstep application through Rasch model.

**RESULTS AND DISCUSSION**

This research has developed 30 items of SMCQs on redox and electrolyte-non electrolyte solution. For each question, there was 5 alternatives. The example of part of SMCQs is shown in Figure 1 below.

**FIGURE 1.** A part of a SMCQs on redox and electrolyte – non electrolyte solution concepts.

After the SMCQs were arranged, it was followed by a review from the judgement expert. Furthermore, the advices from experts are used for the revision of the SMCQs. The quality of SMCQs determined based on teacher assessment through the instrument that has been made. The assesment result of SMCQs is shown in Table 1 below.

**TABLE 1.** The assesment result of SMCQs on redox and electrolyte - non electrolyte solution concept.

<table>
<thead>
<tr>
<th>Aspects</th>
<th>Construct</th>
<th>Structure of the Question</th>
<th>Chemistry Concept</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality (%)</td>
<td>88.00</td>
<td>90.66</td>
<td>88.00</td>
<td>88.46</td>
</tr>
<tr>
<td>Category</td>
<td>Excelent</td>
<td>Excelent</td>
<td>Excelent</td>
<td>Excelent</td>
</tr>
</tbody>
</table>

Although the calculation indicate that SMCQs category excelent, during the data collection process there were some reviewer stating that this type of question are too difficult to student. In their opinion, the student would not be able to understand the alternatives.

The validity of an instrument indicates the level of accuracy of an instrument to measure what should be measured. The validity of items obtained through testing MCQs to the students. There were 160 students of high school as subject for validation of the SMCQs. Data were analyzed using Winstep applications toward Rasch analysis method. The analysis showed that all items, 30 questions, were valid category.
Reliability associated with a level of confidence. A test have a high level of confidence that if these tests provide consistent results. Reliability of the SMCQs determined using Winstep applications. Is is obtained that the reliability value of SMCQs is 0.95. This value is classified as a special category based on the criteria analysis with Rasch models. A test should not be too easy, and also should not be too difficult. An item that is too easy to be answered correctly by all students is not a good item. Similarly, the items that are too difficult so it can not be answered by all students is also not a good item. So the good items are items that have a certain degree of difficulty. The level difficulty of SMCQs was analyzed using Variable Maps on Winstep application. Based on the analysis, the distribution of level difficulty given in Table 2 below.

<table>
<thead>
<tr>
<th>Level difficulty</th>
<th>Easy</th>
<th>Moderate</th>
<th>Difficult</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of items</td>
<td>20</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Percentage (%)</td>
<td>66.67</td>
<td>23.33</td>
<td>10</td>
</tr>
</tbody>
</table>

Based on students and reviewers testimony, the strength of the SMCQs:
1. Can help students not to forget the chemistry concepts that have been studied previously.
2. Making easier for students to understand the chemistry concepts without ignoring the concept that has been studied previously.
3. Can stimulate the curiosity of students to the relationship of chemistry concepts.

CONCLUSION

The result of this study showed that the quality of the SMCQs is excellent (88.46%). The SMCQs on redox and electrolyte – non electrolyte solutions consists of 30 items valid with high reliability. Meanwhile, the difficulty level of the questions were 66.67% easy, 23.33% moderate, and 10% difficult.

Acknowledgments

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References