

Teaching Tools Based on Socio-Scientific Issues on Acid-Base Topic for Chemistry Learning at High School: A Needs Analysis

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ABSTRACT

The purpose of this study was to analyze the need for teaching tools based on socio scientific issue (SSI) on acid-base topics. The researcher explored the learning process and the characteristic of teaching tools which usually used by teachers in public and private high schools in Yogyakarta, Indonesia. A qualitative descriptive study was used in this study. The participants of this study were 16 (9 females and 7 males) chemistry teachers selected by purposive sampling technique. Data were collected using a questionnaire containing several aspects, such as teaching tools, characteristics of teaching tools, and teacher's knowledge about the SSI. The questionnaire had been developed and validated before its use in this study. The data were analyzed descriptively. Based on the study of needs analysis showed that the teaching tools used by the teachers on acid-base topic were still less relevant to student life, did not train students' critical thinking skills, did not contain socio-scientific issues, and did not teach students to solve problems yet seen from various aspects. Hence, for the future, it is required to have SSI-based teaching tools on acid-base topics that can make learning more relevant, and train students' critical thinking skills.

Keywords: *Teaching tool, Socio-scientific issue, Acid-base, Needs analysis.*

1. INTRODUCTION

In the 4.0 industrial era, education is required to be able to make the learning process sustainable and has the potential to improve human quality [1]. Chemistry is a subject that close related to life [2], [3]. One of them is acid-base topic. Two interesting reasons why students should study acid-base, [4] first, acid-base is linked to life closely, students are familiar with the words 'acid', 'base' or 'pH' because many product advertisements used that terminology. Second, this topic is socio-scientific, product advertisements use the words "acid-base" could be categorize as a controversial socio-scientific issue in learning, for example, advertisements for cosmetic products with high pH or 'alkaline' drink products which claimed to improve health. Also, studying acid-base is very important because acid-base is a basic concept for other chemical materials [5].

In the midst of the importance of chemistry concepts that students must understand, chemistry learning is still

being a problem nowadays, including lack of transfer and lack of relevance [6]. Lack of transfer occurs when students can solve a problem if the method is the same as the teacher taught, but they fail to solve the same problem if it is presented differently. Meanwhile, the lack of relevance occurs when chemistry is only a compulsory subject in the curriculum, students study chemistry aimlessly, they only see chemistry as a subject that is less relevant and not useful for themselves [6], [7], [8]. These problems can occur due to several factors, one of which is the lack of planning in learning concerning teacher professionalism [9].

Planning a teaching tool is very important for active student involvement in learning. Teaching without written preparation caused 'teaching by telling' [10], and affect ineffective learning because the teacher did not think in detail about what to do and how to do [11]. In 4.0 era, teachers must be able to conduct learning in order to explore students' competencies, make interactions between students and the environment, and make

learning more relevant [2], [8], [12], [13], teachers should put chemistry in their society, at least as the basic topic that every human being needs to have [14]. When designing a meaningful learning process, firstly, the teacher has to determine the learning objectives by focusing on broad concepts. Secondly, the teacher needs to build and connect the material that students already know. So student understanding can be achieved in a more directed manner [15]. This confirms the importance of compiling teaching tools.

During planning a teaching tool, teachers need to arrange teaching tools, including lesson plans, worksheets, learning media, assessment instruments, etc. Many studies showed that the use of teaching tools based on socio-scientific issues (SSI) in the vicinity is very potential for use in learning, such as the results of the development of learning plans on potato chips that focus on carbohydrates and fat [16]. The topic of low-fat and low-carbohydrate diets was presented in everyday media to foster student competence in reflecting on the use of scientific information in everyday life. The same thing was done by developing and evaluating learning plans with educational topics for sustainable development focusing on plastics and chemical-based industrial product using a socio-critical and problem-oriented approach [17]. The results showed that teaching tools that are connected to socio-scientific issues that are socially relevant have the potential to contribute to student motivation and make students more concerned about the importance of the environment. This caused the development of teaching tools based on socio-scientific issues are needed to support meaningful learning. The study aimed to answer the following questions:

- a. What are the teaching tools used by the teacher on the acid-base topic and how are their characteristics?
- b. How is the teacher's knowledge about SSI?

2. RESEARCH METHOD

This research is a preliminary study, used qualitative descriptive study. Data was obtained from a small group which is described to explain the research results. Participants were selected by purposive sampling technique to get a representative sample. Oral consent was requested from all participants in order to take part in the research. The selected participants had more than 3 years of teaching experience and had used several learning models and methods in their class, it means that they had a good experience with the teaching tools preparation and the implementation of the chemistry learning process. Detail of partisipants was shown in Tabel 1.

Tabel 1. Partisipant of the study

The type of school	Details	Total
8 Public high school	7 women	12
	5 men	
4 Private high school	2 women	4
	2 men	

The instrument for data collection was a semi-closed questionnaire, in which the researcher explored the data through several answer choices accompanied by reasons [18]. The instrument was developed with reference to several studies on needs analysis [19] and analysis of teaching tools research [20]. Based on the results of the study, the instrument used was developed covering three aspects, consist of teaching tools, characteristics of teaching tools, and teacher's knowledge about SSI. These three aspects are considered important as the basis for developing teaching tools based on SSI on the acid-base topic. The questionnaire was validated by an expert to assess the validity of each question item. The result of instrument validation shown in Table 2.

Table 2. Instrument validation

Before validation (item)		After validation (item)	
27	19 valid	24	15 about teaching tools
	5 minor correction		6 about characteristics of the teaching tools
	3 invalid		3 about teacher's knowledge about SSI

The data obtained were analyzed using descriptive statistical analysis techniques, in which the participants' answer choices were converted into percentages, and the participants' reasons were described descriptively.

3. RESULT AND DISCUSSION

3.1. Acid-base Teaching Tools

In the preparation of teaching tools, the learning method is one of the compulsory components, because the learning method is used by the teacher to create a conducive learning atmosphere [20]. There are several learning methods that can used in acid-base learning, such as experiment method, discussion, direct instruction, etc. In this study, based on descriptive analysis, it was found that 62.5% of the teachers implemented combination of experimental, discussion, and direct instruction methods. The teacher admitted that

the three combination methods was able to clarify students' understanding and it was expected that the learning objectives could be achieved. The rest of teachers explained that the experimental method was very necessary while teaching this topic because the enthusiasm of the students was higher and they understood the content faster due to empirical experience. However, 6.25% of teachers still used the direct instruction to explain acid-base, they argued that this method was more effective and efficient.

Besides the learning method, the learning model is also considered as one of the things needed in preparing the learning. Based on 2013 curriculum (curriculum in Indonesia), there are five suggested learning models, namely problem-based learning, project-based, discovery, inquiry, and scientific. The results revealed that 81.3% of teachers implemented discovery learning models when teaching acid-base topic. The teacher stated that this model optimized students' competence. This was related with the research results that guided discovery learning can improve students' critical thinking skills about 87.93%, categorized as very effective [21]. Another study revealed that the use of discovery learning models to teach acid-base can improve students' higher order thinking skill (HOTS) abilities [22]. The teacher added that the learning model is always changing, depending on the characteristics of the students. Furthermore, many studies have stated that various methods and learning models are suitable for teaching acid-base, such as discovery learning [21], problem-solving [23], inquiry learning [24], [25]. Eventually, it was based on characteristics and level of student abilities. The use of learning methods and models on acid-base was shown in Table 3.

Table 3. Learning method and model on acid-base

The type of learning	Details	Percentage (%)
Learning Methods	Discussion + Experiment + Direct Instruction	62.5
	Discussion + Experiment	25
	Experiment + Direct Instruction	6.25
	Direct Instruction	6.25
Learning Models	Discovery Learning	81
	Problem Based Learning	13

The type of learning	Details	Percentage (%)
	Inquiry Learning	6

As much as 100% of teachers use teaching tools in the learning process of acids and bases topic. The teacher stated that the application of teaching tools is needed as a reference in the learning process steps. Teaching tools make it easier for teachers to carry out learning, and make teaching and learning activities more prepared and planned [26]. Based on the source of teaching tools, there were 68.8% teachers making their own teaching tools by modification from various sources, such as books, the internet, etc. The modification from various sources make teaching tools adjusted to the school conditions and have a variety of reference for use in learning. But some teachers just downloaded from the internet and use them immediately. The results of students' worksheets are summarized in Figure 1.

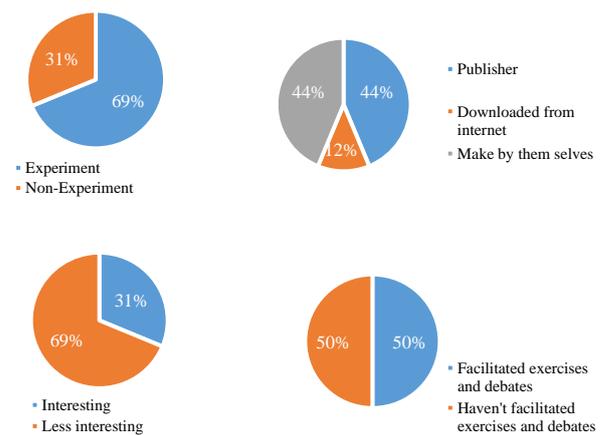


Figure 1 Worksheets on acid-base.

One of the teaching tools used by the teacher on acid-base topic was lesson plan. As much as 100% lesson plans referred to basic and core competencies in the 2013 curriculum, and the formulation of indicators referred to basic and core competencies. However, approximately 60-70% of lesson plans will be implemented by teachers, it was due to adjusting class conditions. Some of the teacher's reasons are "lesson plan is a plan adaptively, there is an adjustment of the lesson plan and improvisation of learning". Besides lesson plans, teachers used worksheets in their lesson. It is because worksheets make teaching easier for teachers to deliver concepts. There were 68.8% of teachers used experimental worksheets, while as much as 31.3% of teachers used non-experimental worksheets. The teachers who have

chosen the experiment worksheet is definitely the teacher who used the experimental method, by focusing on students' enthusiasm. Based on the source of the worksheet, there were 43.8% of worksheets were from commercial publishers, provided by the school. As much as 43.8% of teachers made their own modified worksheets from various sources. Making the worksheets by themselves were expected will be more suitable for the conditions of the tools and materials in the school. This statement showed that the worksheets which were made only containing experimental guidelines for acid and base. Those worksheets were not used as real worksheets concepts, which must be able to develop thinking skills, ask and answer questions, make connections, and assess improvement in students' learning outcomes [27]. Regarding the attractiveness of student worksheets, there were 68.8% of teachers stated that the student worksheets did not have an attractive appearance, the worksheets were still simple, the worksheets were only filled with writing and lacked color. Whereas interesting worksheets will make students more enthusiastic and confident in participating learning process [28]. A good worksheet should also be able to develop students' cognitive understanding, such as containing exercises to encourage students' knowledge of the concepts and to facilitate students' discussion, make argument and evaluate peer opinions regarding the topic [29]. However, as much as 50% of teachers admitted that the worksheets did not cover these two things.

3.2. Characteristics of Teaching Tools Used in Acid-base

The characteristics results of the teaching tools used by teachers are shown in Figure 2.

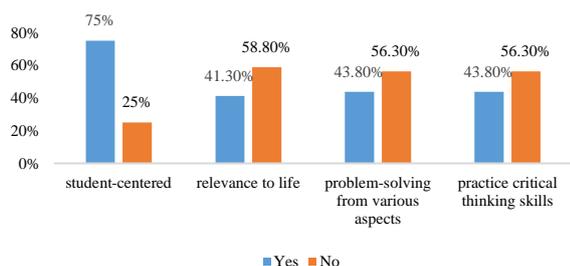


Figure 2 Characteristics of teaching tools on acid-base topic.

The results showed that there were 75% of the teaching tools were categorized as student-centered, even though only on the worksheet. Student-centered learning has been shown to improve the quality of teaching and learning [30] because students participated to influence the process and learning environment. Being student-centered, good learning emphasized the importance of

relevance to students' daily lives [31]. The results showed 58.8% of the teachers stated that some teaching tools used were not relevant to students' lives. In fact, relevant learning was considered as an answer to the question "why students should learn this topic" [7] so students can interpret the topic with their circumstances and living conditions [31]. The teaching tools used by 56.3% have not led students to solve chemical problems from environmental, health, economic, political, and social aspects. To reveal these five aspects, the teacher claimed too much content, the problem was too complex if it included several aspects (environmental, health, economic, political, and social). The teacher explained that sometimes problems were put in learning, but only light problems were used so that only environmental or health aspects could be linked. By integrating SSI in the learning process in the classrooms, students have an understanding of various dimensions, such as scientific, ethnic, cultural, social, economic, and environmental [13].

Good teaching tools trained critical thinking skills because they are important competencies in the era of the industrial revolution 4.0 and are the main skills in the world of work [32]. If it was related to SSI, critical thinking skills can be seen from students' understanding of the nature of science seen from students' ability to analyze and question information, reject conclusions where there is no clear evidence, detect errors of opinion; evaluate the impact of technology on science, and make important conclusions from various aspects [13]. As much as 56.3% of the teaching tools have not trained these abilities, this showed that the teaching tools used also do not have the proper characteristics. However, from all the shortcomings of these teaching tools, there were 62.5% of the teachers stated that they did not experience problems in conducting the acid-base learning process, this was related to the teacher's habits who had compiled their own teaching tools so that they matched what was needed and had to be done.

3.3. Teacher's Knowledge of Socio-Scientific Issues

SSI contribute to student motivation and led to an intense discussion for students potentially. Also, the use of SSI-based teaching tools can improve high-level cognitive skills from the perspective of science, technology, and society (STS) [33]. The use of SSI in the classroom made students more concerned about the environment [34] and understands Education for Sustainable Development (ESD) [17]. In Fact, there were 31.3% of teachers did not know about SSI. As much as 68.8% of teachers knew SSI by stating "SSI is related to the benefits and impacts of learning chemistry" contrasty

or "science issues that affect the environment and social" and some stated that SSI is similar to a problem-based approach. The results showed that there were 68.8% of the teachers had never prepared teaching tools based on SSI due to the lack of understanding of the teachers in various kinds of developments. The biggest teachers' reason may face in the preparation of SSI-based teaching tools is the difficulty in linking social issues with chemical concepts. Other reasons were expressed by the teacher related to the limited time available, for example, the following reasons:

A: "Adjusting to the curriculum and curriculum targets with time allocations".

B: "It is difficult to find a theme to fit the learning concept and need a lot of time and energy to prepare for learning, sometimes the results/implementation are not as desired".

By using SSI in learning activities, teachers must understand the chemistry content and socio-scientific problems used, because teachers act an important role in learning success [35], [36]. Naturally, the teacher felt a lot of time to prepare the material and problems that will be used because the teacher has to analyze the learning material and the socio-scientific issues that will be used. In fact, many SSI contexts can be used in learning. Examples of related issues that can be used in the study include acid rain, detergent use, biofuels [36], air quality, nutrient content in food [16], natural cosmetics [37], water quality, volcanic eruptions, vaccines [38], and much more. Also, Indonesia is an archipelago consisting of various ethnicities and cultures, so SSI is very suitable for use in chemistry learning [38]. The research data on teachers' knowledge of SSI is depicted in Figure 3.

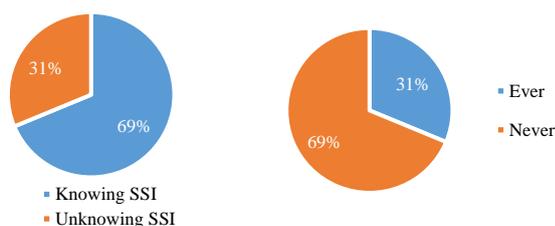


Figure 3 Teachers' knowledge about SSI.

There were 31.3% of teachers who had compiled SSI-based teaching tools, such as polymer material associated with plastic waste. The teacher admitted the discussion method that involved socio-scientific issues greatly supported the students' scientific literacy skills. All the participants involved in the study agreed to develop socio-scientific based teaching tools on acid and base. Participants stated that SSI-based teaching tools have the potential to encourage students to explore their understanding of acid and base, increase student's critical thinking skills [13], and make learning more relevant to

daily life [7], [37] so that students were expected to be more confident in learning chemistry [13], [39].

4. CONCLUSION

Based on the results of data analysis, several conclusions were obtained. 1) On acid-base topic, teachers used lesson plans and worksheets as their teaching tools by using methods and models related to school conditions and student characteristics. 2) The characteristics of teaching tools were still less relevant to student life, had not led students to solve problems seen from various aspects, and do not train students' critical thinking skills. 3) Teachers' knowledge about SSI were still lack. Their ability and time to prepare teaching tools based on SSI were still considerable problems. Lastly, the use of SSI-based teaching tools in chemistry learning was expected to be not only seen as a subject but more than that. The chemistry is closely related to the daily life of students and very applicable. Therefore, the results of this study can be used as a good basis for the development of SSI-based teaching tools on acids and bases. In the end, learning on the acid-base topic can be more relevant to student life, and students' critical thinking skills can be trained.

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