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What Do Chemistry Teachers Say About Scientific Creativity and the Development of Rosella Flower Extract Indicators as a Learning Medium for Acid-Base Titration?

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Abstract: The rapid development of industry 4.0 makes scientific creativity an important skill for every individual to be able to adapt and develop. Therefore, in the learning process, it is necessary to provide for the development of students' scientific creativity both as a professional skill and as a general life competency. This research aims to describe teachers' perceptions of learning acid-base titration using natural indicators from Rosella Flower extract to increase students' scientific creativity. The research method used was a survey method by distributing questionnaires to 21 high school chemistry teachers throughout Bandar Lampung City. The results of the research show that 100% of teachers have never developed an acid-base titration indicator from Rosella flower extract, and trained students' scientific creativity by providing a real problem. Based on these findings, it can be concluded that it is necessary to develop natural indicators from Rosella Flower extract as a learning medium for acid-base titration to increase students' scientific creativity.

Keywords: Acid base titration; Rosella Flower extract indicator; Scientific creativity

Introduction

The rapid development of industry 4.0 makes scientific creativity an important skill for every individual to be able to adapt and develop (Voogt & Roblin, 2012; Yakymchuk et al., 2019). Through scientific creative thinking, individuals are able to utilize the knowledge gained into ideas that can be used as solutions to problems (Umam et al., 2021). Therefore, in the learning process it is necessary to provide for the development of students' scientific creativity as a professional skill and as a general life competency (Yakymchuk et al., 2019). However, the fact is that students' scientific creativity is still low (Prahani et al., 2021; Suyidno, 2019; Astutik et al., 2018; Jatmiko et al., 2016). Low scientific creativity is caused by conventional and monotonous learning which tends to only conceptualize and manage routine problems (Zainuddin et al., 2020).

The chemistry learning process, especially the topic of acid-base titrations, has so far only led to understanding concepts related to writing and balancing chemical reactions equations, to determining the valence of acids and bases, determining the type of titration based on the titration curve and dermining the equivalence point in titrations of weak acids and strong bases (Astuti & Marzuki, 2018). Such learning has not been able to direct students to real problems so that students' scientific creativity does not develop.

One of the efforts that has been made to increase students' scientific creativity is through project-based learning (Rosaria et al., 2023; Rosaria et al., 2023). Project-based learning requires students to be able to utilize the knowledge they have to generate ideas to solve problems. Through learning like this, students also have the ability to change the way they solve problems and are not stuck with initial approaches that are less efficient. Apart from that, this kind of learning also

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allows students to provide ideas without being influenced by anyone else's ideas, thus producing unique and original solutions in solving problems. The results of this research show that students' scientific creativity can be trained through project-based learning by linking it to real problems in everyday life. Apart from using project-based learning, learning media is also very useful in creating and developing various skills that students need (Aninnas et al., 2023; Wahyuni et al., 2021; Luh & Ekayani, 2021; Janah et al., 2018).

One of the learning media that can be developed is acid-base indicators. An acid-base indicator is an organic compound that can change color with changes in the pH of the solution (Pathade et al., 2009). Acid-base indicators that are often used in laboratories today are synthetic indicators such as litmus paper, universal indicator paper, phenolphthalein, methyl red, and bromine thymol blue (Abuh et al., 2018). However, indicators like this have several disadvantages such as limited availability, high production costs, relatively expensive prices and can cause environmental pollution problems (Pathade et al., 2009; Yazid et al., 2018).

The use of synthetic indicators can be replaced by using natural indicators derived from plant pigments from flowers, leaves, fruit or skin (Macuvele et al., 2016). Several research results show that extracts from natural products and their corresponding pKa have been identified as natural indicators for acid-base titrations such as dragon fruit peel (7.33-9.33) (Meganingtyas & Alauhdin, 2021), red onion skins (8-9) (Virliantari et al., 2018), bougainvillea glabra (7-10) (Kapilraj et al., 2019), and mangosteen rind (6.2-8.2) (Tania et al., 2019). One other type of plant that has the potential to be used as a natural indicator is the Rosella Flower (Hibiscus Sabdariffa Linn).

Rosella Flower extract has been widely used as an alternative indicator in acid-base titrations. When titrating a weak acid with a strong base, Rosella Flower extract shows different color changes and pH ranges. Rosella Flower Extract shows a pink-yellow color change (Yazid et al., 2018); as well as red-green (Nuryanti et al., 2013; Genevieve, 2020). The pH range for Rosella Flower extract from previous researchers was (3.4-9.0) (Genevieve, 2020); (4.3-5.3) (Yazid et al., 2018); (5.85-9.55) (Nuryanti et al., 2013). These results indicate that there is a possibility that researchers will obtain different data from the development of Rosella Flower extract indicators that have been carried out previously by paying attention to the growth factors of the plant where the Rosella Flower grows, such as temperature, humidity and air quality (Himawan et al., 2021; Widiya et al., 2019). Apart from that, what differentiates this research from previous researchers is that the results of developing indicators from Rosella Flower extract are used to overcome real problems in everyday life so that with such learning it is hoped that students' scientific creativity can develop.

Real problems in everyday life can be problems regarding environmental pollution caused by various types of waste, for example liquid waste from the tofu industry. The quality standard set by Minister of Environment and Forestry Regulations Number 68 of 2016 for tofu liquid waste is pH 6-9, while tofu industrial wastewater tends to be acidic (Hamzani et al., 2020; Dewa & Idrus, 2017). The effect that occurs if the pH is too low is a decrease in dissolved oxygen. A decline beyond the threshold will result in the death of aquatic biota due to lack of oxygen (Sayow et al., 2020; Mardhia & Abdullah, 2018). Therefore, the pH parameters of tofu liquid waste must be identified first so that it can be given appropriate treatment so that it is safe to dispose of into the environment (Sayow et al., 2020). Determination of pH in tofu liquid waste can be done through acid base titration using learning media in the form of Rosella Flower extract as an indicator.

Based on the problems above, it is predicted that natural indicators from Rosella Flower extract can be a learning medium in order to increase students' scientific creativity. Therefore, this research aims to determine teachers' perceptions of whether natural indicators from Rosella Flower extract can be a learning medium in order to increase students' scientific creativity.

Method

The research was conducted at public and private high schools in Bandar Lampung City for the 2022/2023 academic year. The research method used in this research is the survey method. The data collection technique used was distributing questionnaires to 21 high school chemistry teacher respondents in the city of Bandar Lampung.

The data obtained was analyzed by classifying the data, tabulating the data based on the classifications made, and calculating the percentage of answers using the following formula:

$$\%X_{in} = \frac{number\ of\ answers\ for\ each\ group}{total\ number\ of\ respondents} \times 100 \quad (1)$$

Information: $\%X_{in}$ = Percentage of each group of answers

Results and Discussion

The results of public and private high school chemistry teachers' perceptions in Bandar Lampung City regarding learning acid-base titration using learning media in the form of Rosella Flower extract in increasing students' scientific creativity are shown in table 1.

Based on Table 1, we can see that all respondents consider creativity to be one of the most important skills to face current developments. However, it turns out that only 61.90% of respondents have trained students' creativity in learning such as on the topics of electrolyte and non-electrolyte solutions, redox reactions, hydrocarbons, reaction rates, acids and bases and colligative properties of solutions. Another 38.10% of respondents emphasized student development in the realm of knowledge. The creativity that has been trained so far refers to the framework according to Torrance (2012) which is an effective way for students to practice fluency, flexibility, originality and elaboration. Table 1 also shows that 71.43% of respondents do not know the difference between scientific creativity and creativity in general. Even so, as many as 28.57% were aware of this difference, but it turned out that all respondents said they had never trained students' scientific creativity in learning at school.

Table 1. Interpretation of Teacher Questionnaire Results

Question	Percentage (%)	
	Yes	No
In the era of revolution 4.0, do you think creativity is one of the most important skills for students?	100	0
Have you ever trained students' creativity in learning?	61.90	38.10
Scientific creativity is different from other general creativity, do you know the difference?	28.57	71.43
Have you ever trained students' scientific creativity in learning?	0	100
Do you agree that scientific creativity can help students solve problems by creating various ideas and being able to find unique and original solutions in solving problems?	100	0
One of the efforts to increase students' scientific creativity is through project-based learning by relating real problems to everyday life, do you agree with this statement?	100	0
In your opinion, is it necessary to use real problems in everyday life in learning, especially in learning acid-base titration?	100	0
Is the acid base titration learning that you have been doing so far based on real problems in everyday life?	14.29	85.71
Have you ever connected problems related to tofu liquid waste with learning about acid-base titration?	0	100
Have you ever done acid-base titration practice with your students at school?	52.38	47.62
Have you ever used various types of learning media on the topic of acid-base titration?	100	0
Have you ever developed a natural indicator from rosella flower extract as a learning medium for acid-base titration?	0	100
Do you still use synthetic indicators in carrying out acid-base titration practice?	100	0
Do you agree with the use of synthetic indicators such as fenolphthalein replaced with a natural indicator from rosella flower extract?	100	0
Are you interested in using rosella flower extract as a learning medium for acid-base titration?	95.24	4.76
Do you agree, if researchers plan to develop learning media in the form of acid-base indicators from rosella flower extract?	95.24	4.76

As many as 85.71% of respondents said they had never applied problem-based learning on the topic of acid-base titration. This is because problem-based learning requires quite a long time and respondents feel less confident in implementing problems that are appropriate to learning acid-base titrations. However, all respondents felt it was necessary to apply it so that learning became more meaningful. All respondents also said that they had never related the topic of tofu liquid waste problems in learning acid-base titration. However, as many as 14.29% of respondents said that the problem-based learning on the topic of acid-base titration that had been applied was related to determining the levels of certain substances contained in food vinegar products.

As many as 52.38% of respondents applied acid-base titration learning by carrying out practicums. Practicums are carried out by paying attention to the availability of tools and materials in the school laboratory. Several obstacles during the implementation of the practicum were inadequate titration practicum equipment, practicum materials that had expired, limited practicum time and limited laboratory space because it was used as a temporary classroom until the process of building the new class was complete. The remaining 19.05% of respondents used the lecture method and 28.57% of respondents used the group discussion method in learning acid-base titration.

So far, the learning media used by respondents on the topic of acid-base titration include practical tools and materials, package books and worksheet. Acid-base indicators can also be used as a learning medium. However, all respondents said they had never developed their own acid-base titration indicators. So far, the natural indicators that have been developed are natural indicators for practical purposes in determining the properties of solutions (acid, base, neutral). The reason why respondents did not develop their own acid-base titration indicators was due to a lack of references and understanding regarding making correct acid-base titration indicators. So far, the indicator used by respondents in acid-base titration practice is the phenolphthalein indicator because it is considered more practical and is available in school laboratories. However, all respondents agreed that the continuous use of these indicators can pollute the environment and are relatively expensive, so they need to be replaced with natural indicators from plant extracts such as Rosella Flowers. Therefore, this research focuses on developing natural indicators from Rosella Flower extract as a learning medium for acid-base titration to increase students' scientific creativity.

The following is data from interviews conducted with 4 chemistry teacher respondents from different schools. This interview was conducted to determine respondents' perceptions about students' scientific creativity, methods and models used in learning chemistry and acid-base titration indicators.

Teachers' Perceptions Regarding Students' Scientific Creativity

Based on data collection through questionnaires, it shows that teacher respondents have never trained students' scientific creativity. In this interview, we will explore further the teacher's understanding of students' scientific creativity.

Interviewee 1 stated: "I have trained students' creativity in learning chemistry, especially on the topic of reaction rates. The creativity of students who are trained refers to the framework according to Torrance (1990) such as training fluency, flexibility, originality and elaboration. But for scientific creativity, I have only heard of the term and have never practiced it in chemistry lessons. In my opinion, scientific creativity is different from creativity in general because scientific creativity uses scientific principles in conducting experiments or research."

Interviewee 2 stated: "I have trained students' creativity in learning chemistry, especially on the topic of acids and bases. But as for scientific creativity according to Jongwon Park, I have never heard of it and have never trained it in studying chemistry. In my opinion, what differentiates scientific creativity from creativity in general is that scientific creativity is more standard by using a scientific approach, while general creativity is more flexible."

Interviewee 3 stated:" I have trained students' creativity in learning chemistry, especially on the topic of electrolyte and non-electrolyte solutions. But as for scientific creativity according to Jongwon Park, I have never heard of it and have never trained it in studying chemistry. "In my opinion, scientific creativity and creativity in general are certainly different because scientific creativity combines the concepts of creativity with science and uses a scientific approach."

Interviewee 4 stated: "I have never trained students' creativity in learning chemistry, either creativity according to the Torrance framework or students' scientific creativity according to Jongwon Park. So far, I have emphasized student development in the realm of knowledge. However, I believe that knowledge, skills and attitudes are very important for students to have in order to be able to adapt to current developments."

Based on the results of these interviews, the findings obtained were that teachers had never trained students' scientific creativity. So far, teachers only know the term creativity in general which refers to the framework according to Torrance (1990) which includes fluency, flexibility, originality and elaboration. In fact, student creativity in the field of science or what is called scientific creativity, is different from creativity in general because scientific creativity is related to scientific experiments, discoveries and creative problem solving and is active in scientific activities (Amabile, 1987; Hu et al., 2002; Lin et al., 2003; Alexander, 1992; Setyadin et al., 2017). According to Park (2012) scientific creativity includes thinking creatively in a scientific context, conducting scientific inquiry creatively, and understanding and applying scientific concepts creatively.

Teachers' Perceptions Regarding the Models and Methods Used in Chemistry Learning

Based on data collection through questionnaires, it shows that teacher respondents use different learning models and methods. In this interview, we will explore further the extent of the teacher's understanding of the models and methods applied in chemistry learning.

Teacher resource person 1 stated: "I have never used tofu liquid waste problem-based learning on the topic of acid-base titration. Usually, on this topic I use an inquiry learning model where students are guided to determine the levels of a certain substance contained in industrial products such as food vinegar. I used a practical method on this topic. "Some of the obstacles I faced during the practicum were limited practicum time due to the dense concepts that students had to understand and the curriculum demands to complete all the material."

Teacher resource person 2 stated: "I have never linked learning acid-base titration with problems related to water pollution due to tofu liquid waste. Usually, I use the discovery learning model in learning acid-base titrations. I usually take the problems presented from examples in the textbook. I used the practical method in the topic of acid-base titration. "Some of the obstacles I faced during the practicum were the limited practicum space (laboratory) because the lab room was used as a substitute class while the new class was being built."

Teacher resource person 3 stated: "I have never linked learning acid-base titration with problems related to water pollution due to tofu liquid waste. Usually, I use the discovery learning model in chemistry lessons, especially on the topic of acid-base titrations. The problem I present is related to determining the levels of a substance in food vinegar. I used a practical method on this topic. "Some of the obstacles I faced during the practicum were that many of the practicum materials had expired."

Teacher resource person 4 stated: “I never related learning acid-base titration to real problems in everyday life. So far, I have used the lecture method, especially on the topic of acid-base titration. This is because it is not possible to carry out practical work due to the unavailability of adequate tools and materials to carry out acid-base titration practice. "Usually, after explaining the material, I give worksheet, students discuss, ask questions and practice questions."

The findings obtained from the interview are that the learning model applied in learning acid-base titration so far is inquiry learning and discovery learning by taking problems related to determining the levels of a substance contained in food vinegar. Problem-based learning has been applied even though it takes different problem topics. The interview results also showed that resource person 4 still carried out conventional learning using lecture, discussion, question and answer and practice questions methods. Such as learning has not been able to direct students to real problems so that students' scientific creativity does not develop. Low scientific creativity is caused by conventional and monotonous learning (Zainuddin et al., 2020).

Teachers' Perceptions Regarding Acid-Base Indicators

Based on data collection through questionnaires, it can be seen that all respondents have never developed acid-base titration indicators. To find out more, an interview was conducted.

Teacher Resource 1 stated: "During the acid-base titration practicum, I prepared the phenolphthalein indicator as a synthetic indicator which was practical to use because it was available in the school laboratory. I have never made a natural indicator from Rosella Flower extract for acid-base titration practice. I am interested in the research that will be carried out regarding the development of natural indicators from Rosella Flower extracts. I hope this research can train students' scientific creativity."

Teacher Resource 2 stated: "During the acid-base titration practicum, I prepared the phenolphthalein indicator as a synthetic indicator that was practical to use because it was available in the school laboratory. I have also made natural indicators, for example from hibiscus flowers, but that was used for the topic of determining the nature of a solution (acid, base, neutral). Meanwhile, for acid-base titration practice, I have never made my own natural indicator. I have also never made a natural indicator from Rosella Flower extract for acid-base titration practice. I am interested in the research that will be carried out regarding the development of natural indicators from Rosella Flower extracts. I hope this research can train students' scientific creativity."

Teacher Resource Person 3 stated: "During the acid-base titration practicum, I prepared the phenolphthalein indicator. I have also made natural indicators, for example from turmeric, but that was used for the topic of determining the nature of a solution (acid, base, neutral). Meanwhile, for acid-base titration practice, we have never made our own natural indicators. I have also never made a natural indicator from Rosella Flower extract for acid-base titration practice. I am interested in the research that will be carried out regarding the development of natural indicators from Rosella Flower extracts. "I hope that this research will be able to train students' scientific creativity and increase students' interest in studying chemistry."

Teacher Resource 4 stated: "I have never made a natural indicator from Rosella Flower extract for acid-base titration practice because of the lack of references and understanding regarding the development of natural indicators for acid-base titration practice. I am interested in the research that will be carried out regarding the development of natural indicators from Rosella Flower extracts. "I hope that this research will be able to train students' scientific creativity and improve students' skills in carrying out practicums."

Based on the results of these interviews, the findings obtained were that all teacher speakers had never developed natural indicators for acid-base titration. So far, teachers have used synthetic indicators in the form of pp indicators. Indicators like this have several disadvantages such as limited availability, high production costs, relatively expensive prices and can cause environmental pollution problems (Pathade et al., 2009; Yazid et al., 2018).

All teachers agree and are interested in research into the development of natural indicators from Rosella Flower extract as a learning medium to increase students' scientific creativity.

Conclusion

Based on the results of research and discussions, there are still many teachers who do not know and have never trained students' scientific creativity in chemistry learning at school. As many as 100% teachers have never developed an acid-base titration indicator from Rosella Flower extract. All teachers had never carried out learning based on liquid waste problems on the topic of acid-base titration. Based on the overall results of questionnaires and interviews conducted with chemistry teachers, it is necessary to develop natural indicators from Rosella Flower extract as a learning medium to increase students' scientific creativity. It is hoped that this research will be useful for students in the current era of globalization.

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