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CHARACTERIZE ZNO NANOPARTICLES' MORPHOLOGY AND CRYSTAL STRUCTURE, RESPECTIVELY TO GIVING THIS MATERIAL FOR FURTHER LEARNING TO STUDENTS

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Abstract
This study aims to characterize Zno Nanoparticles' Morphology and Crystal Structure, Respectively to Giving This Material for Further Learning to Students. The method used in this study: (i) understanding how to synthesize ZnO nanoparticles using a liquid-phase synthesis (ii) implementation of ZnO nanoparticles to students and analysis their comprehension using Transcript Based Lesson Analysis (TBLA) on the Learning Video Recording and Adaptation Learning Transcript. To support this study, several analyses were done, such as a scanning electron microscope (SEM) and X-ray diffraction (XRD) to characterize ZnO nanoparticles' morphology and crystal structure, respectively, prior to giving this material for further learning to students. Experimental results showed that the use of ZnO is effective to improve the student comprehension. Students become more serious in listening during the learning process. They also have been more curious to study science and technology.

Keywords: Zinc oxide nanoparticles, Powder technology, Education, Learning

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INTRODUCTION

Efforts to connect science with technology can be done through techno-science education. Techno-science connects abstract concepts to be more tangible in the material-cognitive design medium, which provides students with a concrete view on modelling as a means to produce scientific knowledge (Z.L. Wang, 2004). In the context of chemistry, techno-science is called techno-chemistry. Techno-chemistry refers to activities originating from chemical experiments, which are fundamentally and based on a certain set of values, transforming the reality of life (2. Z. Fan, 2005). Techno-science learning taken in this study is learning techno-chemistry using zinc oxide nanoparticles material as a model.

Many papers have reported the use of techno-chemistry in teaching students. For example, implemented zinc oxide (ZnO) nanoparticles for students learning. Excellent results were obtained, shown by excellent responses from students and teachers. In short, they implemented ZnO nanoparticles for their high UV absorption ability (Madathil, Vanaja, & Jayaraj, 2007).

In our previous study we ha have reported how to teach science and nanotechnology to students (Haristiani, Aryanti, Nandiyanto, & Sofiani, 2017), (Nandiyanto et al., 2018). Here, the purpose of this study was to evaluate the effectiveness of ZnO nanoparticles as learning media for supporting teaching senior high school students. Different from other reports,.

The main reason for the use of ZnO nanoparticles is because this type of material can be prepared easily and rapidly from zinc raw material. This material can be also found in daily life, shown by various ZnO-related products such as sunscreen (M. Hosokawa et al., 2007) and white light sources (Wilke et al., 2014).

METHOD

1. Synthesis of Zno Nanoparticles

ZnO nanoparticles were synthesized using a liquid-phase synthesis. ZnO nanoparticles were produced by reacting zinc acetate ($Zn(CH3COO)2$. $2H2O$; Sigma Aldrich, US) and sodium hydroxide (NaOH; Bratachem, Indonesia) in ethanol solution (99%; Merck, Germany). In short, the synthesis procedure was done into three steps: (i) diluting reactants, (ii) reaction process, and (iii) purification.

The first step was done by dissolving zinc acetate and NaOH separately into ethanol. Zinc acetate was dissolved at temperature of 60·C for 2 hours, whereas NaOH dissolution was done at 40·C for 2 hours.

In the second step, both reactants (i.e. zinc acetate and NaOH solutions) were put into borosilicate reactor and mixed for 2 hours. In this study, we varied the concentrations of zinc acetate (from 0.10 to 0.50 M) and NaOH (from 0.07 to 0.35 M).

In the final step, the mixed solution was then put into a centrifugation process (11,000 rpm; 5 minutes). The centrifuged samples were then dried at temperature of 100·C in electrical furnace to remove solvent. The con

To confirm that the ZnO nanoparticles were successfully produced, the samples were then characterized using a scanning electron microscope (SEM; SU-3500, Hitachi, Japan; for analyzing particles' size and morphology) and a powder X-ray diffraction (XRD; Smartlab 3kW, Rigaku, Japan; for analyzing the crystal structure formed in the sample).

2. Teaching ZnO nanoparticles to students

The study was conducted on 20 senior high school students in Bandung with ages of 16 -17 years old. To teach the concept on the implementation of ZnO nanoparticles, we conducted into several steps:

a. Synthesis of ZnO nanoparticles were demonstrated to students
b. The implementation of ZnO nanoparticles in teaching and learning was done in 2 x 45 minutes.
c. The learning process is recorded with the aim of seeing the dialogue during learning process. Learning video was encrypted as a transcript using Transcript Based Lesson Analysis (TBLA).
d. The TBLA analysis was characterized in four segments.
e. The analysis of learning transcripts was focused on student dialogue in learning and classified based on the type of response. This response is compared as a communicative function for representing the construction of student knowledge (See Table 1) (Tairab, 2010).

Table 1
Response type classification

Response Type	Coding	Description
Interrogative	Q	Ask for pieces of opinion, information, advice or clarification
Responsive	A	Answering questions or providing clarification
Suggestive	S	Give advice relating to the topic of discussion
Informative	I	Provide information related to the topic of discussion. Information in the form of theoretical knowledge
Exemplification	EX	Give a concrete / real example
Elaborative	EL	Develop further pieces of information, suggestions or examples offered previously
Justificational	JT	Justify pieces of information, suggestions or examples
Reasoning	RE	Give reasons about knowledge
Evaluating	EV	Provide positive feedback on pieces of information, suggestions and examples offered previously
Judgmental	J	Expressing agreement to pieces of information, suggestions or examples offered
Summarizing	S	Summarize pieces of information, suggestions or examples given previously

RESULTS AND DISCUSSION

1. Synthesis and characterization of zno nanoparticles

Figure 1 shows the SEM analysis images of ZnO nanoparticles prepared with various concentrations of reactants. The results showed that various particles' morphologies were obtained.

When using concentration ratio of zinc acetate and NaOH of 0.05/0.35 (See Figure 1 (a)), the particles had spherical shapes with mean sizes of 533 nm. Some particles were agglomerated. Broad sizes of particles were obtained, which were in the range of xxx to xxx. When the concentration ratio was 0.10/0.07 (See Figure 1(b)), the spherical particle sizes were about 399 nm. When the concentration ratio was 0.20/0.14 (See Figure 1(c)), flakes with mean sizes of about 400 nm were obtained. When using a concentration ratio of 0.50/0.35 (See Figure 1 (d)), the larger flakes were obtained, in which the mean sizes were about 500 nm. Flakes were transformed into flower-like flakes.

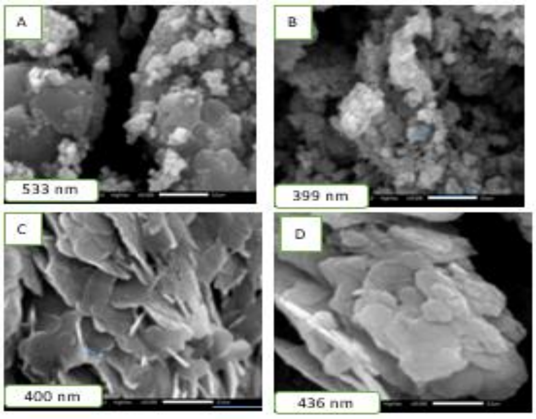

Fig. 1. SEM images of ZnO nanoparticles prepared with various concentration ratios of Zn(CH3COO)2 and NaOH: (a) 0.05/0.35; (b) 0.10/0.07; (c) 0.20/0.14; (d) 0.50/0.35.

Figure 2 shows the XRD analysis results of samples prepared with various concentrations of reactants. The XRD showed the qualitative and quantitative data from the ZnO nanoparticles. The crystal structure and crystallinity of ZnO nanoparticles were identified, in which this has been confirmed by the Join Powder Diffraction System (JCPDS) no 05-0664 (Kanade, Kale, Aiyer, & Das, 2006). The results showed that the sequential standard peaks at 31.75; 34.44; 36.25; 47.54; 56.55; 62.86; 66.38; 67.91; 69.05; 72,60; and 76.95· were identified, which were identical to ZnO structure. The change in the reactant composition was found in the XRD intensity only, but the crystal structures (XRD patterns) are still for ZnO material.

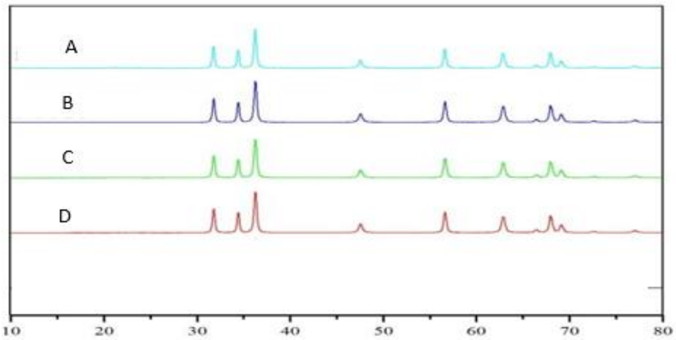

Fig. 2. X-ray diffraction patterns of ZnO nanoparticles prepared with various concentration ratios of zinc acetate and NaOH: (A) 0.05/0.35; (B) 0.10/0.07; (C) 0.20/0.14; (D) 0.50/0.35.

2. Analysis of learning ZnO nanoparticles

Figure 3 shows the construction patterns based on VNOST analysis. In this figure, we divided figures based on 4 segments. In each segment, we used 11 types of response. However, in all segments, there are only 5 or 6 types of responses. Most of the types of responses were 2, 4, 6, 8, 10, and 11, corresponding to responsive, informative, elaborative, reasoning, judgmental, and summarizing, respectively.

Figure 3(a) provides information that there are five types of responses appeared in segment-1. The five responses (i.e. 2, 4, 6, 8, and 10) showed that the dialogue between our study and students related to aspects of the definition of science and technology more directed towards responsiveness. However, the answers from students still use the term of repetition from teachers. Indeed, this gives information that the students have not yet understood correctly.

Figure 3(b) provides information related to the types of responses that arise in aspects of the epistemology of science. There are five types of responses: 2, 4, 6, 8, and 10. Based on the types of responses, it can be interpreted that dialogues between students and teachers are more dominant in the judgmental type. Judgmental type provides an illustration that students can express only approval for pieces of information, suggestions, or examples [11].

Figure 3(c) provides information related to aspects of internal sociology of science. We found four types of responses (i.e. 2, 4, 6, and 10). In this segment, informative response types are more dominant in learning on the topic of ZnO nanoparticles. Informative type illustrates that students provided information in the form of knowledge related to the topic under discussion (Tala, 2009).

Figure 3(d) shows information that the type of response arising in segment 4. There are six responses appearing: 2, 4, 6, 8, 10, and 11. The appearance of the summarizing type provides information that students can summarize pieces of information, suggestions, or examples explained previously (Tala, 2009). This also shows the information given by the teachers to students are not done directly, but teacher's guide and help students to achieve information and build critical perspective (Rubba & Harkness, 1996).

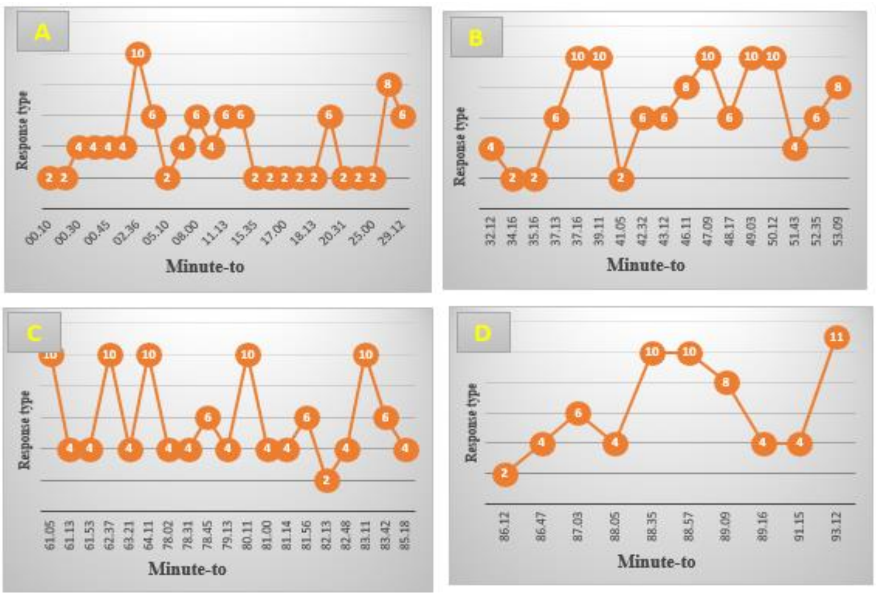

Fig. 3. Student construction patterns: (a) Segmen-1 (0-29s); (b) Segmen-2 (32-53s); (c) Segmen-3 (61-85s); (a) Segmen-4 (85-93s).

CONCLUSION

This study characterize Zno Nanoparticles' Morphology and Crystal Structure, Respectively to Giving This Material for Further Learning to Students. We found that the use of ZnO is effective to improve the student comprehension. Students become more serious in listening during the learning process.

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