Utilization of Diamond Software as a Measuring Tool for Student Scientific Attitude

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Abstract – *Solid state is a compulsory subject in Physics Education study program. Therefore, the level of complexity—depth—of the material taught is moderate. However, students are facing some obstacles in understanding crystal structure material that is related to microscopic structures. This research aims to apply diamond software media to crystal structure material, from which students' scientific attitude can be discovered. The method used in this study is qualitative description. The research subjects totaled 23 students. The data collection technique was carried out by measuring students' scientific attitudes after using the Diamond software. The results showed that the Diamond software could be used in Solid State Physics course. In contrast, the scientific perspective showed good results, which is indicated by the scientific attitude questionnaire score reaching more than 80% within the high category. Meanwhile, student responses indicate that the acceptance rate of Diamond software as a learning medium in Solid State Physics course is 86.25%, or falls into the high category.*

Keywords*: Microstructure; Solid State; Crystallography; Scientific Attitude; Diamond Software*

INTRODUCTION

Solid State Physics is one of the compulsory subjects for the Bachelor of Physics Education study program. Students can take this course in the 7th semester or even sooner if the previous prerequisite course, that is, the Nuclear Atom Physics course, has been completed. Students' level of understanding in taking this course has a different depth of material compared to the Physics study program. In Physics Education study program, the depth level includes understanding the theoretical basis, considering that the scope for research in the field of solids has not been facilitated.

Solid State physics is a branch of physics that studies solids (Damanik, 2020), which involves atomic-scale phenomena (Irzaman et al., 2015). The material taught in this course is limited to crystal structure, X-Ray Diffraction, crystal bonds, crystal vibrations, crystal thermal systems, free-electron gases, energy bands, semiconductor crystals, conductivity, and magnetism of solids (Yani et al., 2021). One of the materials in Solid State is crystal structure. The crystal structure is the unique arrangement of atoms in a crystal. In solid crystals, molecules are arranged in regular three-dimensional patterns and extend from various directions.

Scientific attitudes are a part of the scientific process. Therefore, scientific attitudes will reveal behavior in teaching and learning (Negoro & Ningtyas, 2019). Scientific attitudes have several visual aspects, namely curiosity, honesty, thoroughness, not accepting the truth without evidence, accepting new ideas, and respecting the opinions of others (Carolina et al., 2019). Through a scientific attitude, it is hoped that students can behave like scientists (Khery et al., 2020). This is because scientific attitudes influence learning achievement and learning outcomes.

In the implementation of learning, crystal structure materials taught are sourced from lecturers or teaching materials have not used supporting applications as demo materials in education. Therefore, it causes the comprehension of microscopic images to be difficult for students. An application that can be used as media for crystal structure learning is Diamond software. Diamond software is an application that can visualize molecular and crystal structures (Agus, 2021). Students' understanding on the use of the application for crystal structure materials can be determined using a scientific attitude questionnaire. Meanwhile, student response questionnaire was only used as a material to support the decision on the app's acceptance rate as a learning medium.

RESEARCH METHODS

This research was carried out following the research flowchart in accordance with Figure 1.

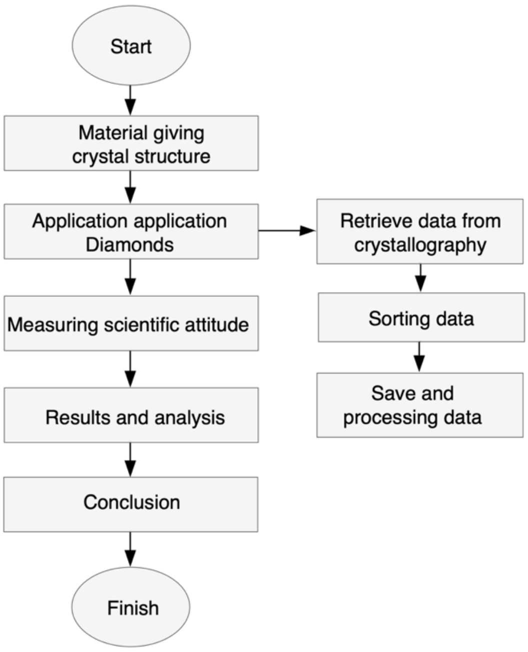

Figure 1. Research flowchart

The research method used was qualitative descriptive method. The research subjects are students who are currently or have taken the Solid-State Physics course. The number of students involved in this study was 23 (twenty-three) people.

Data collection are conducted by providing crystal structure material, in which students understand data collection through the website http://www.crystallography.net/ (according to Figure 2). The data obtained is then analyzed using the Diamond application (figure 3).

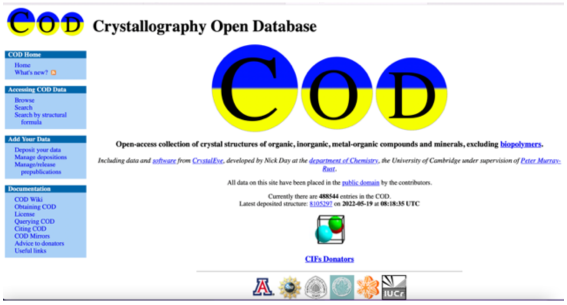

Figure 2. Website display http://www.crystallography.net/

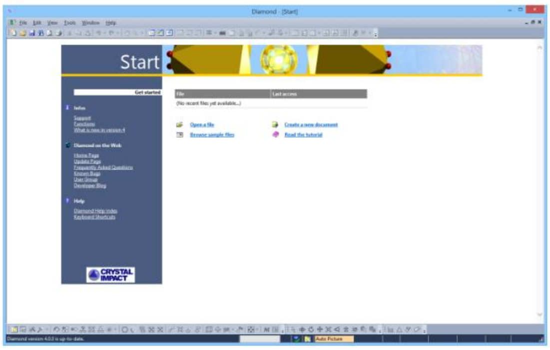

Figure 3. Diamond software display

Table 1. Scientific attitude instruments

No.	Scientific attitude	Item number
1.	Curiosity	7
2.	Critical Thinking	5
3.	Respect for data	9
4.	Perseverance	5
5.	Open-mindedness	7
6.	Cooperation	7

Students' understanding of the process of using the Diamond application was measured using a scientific attitude questionnaire. The instrument outline follows table 1. The instrument was arranged with a choice of statements using a Likert scale, namely True (B), Mostly True (SBB), Partly True (SKB), and Not True (TB).

The feasibility analysis results for scientific attitudes validate the criteria for content, presentation and language component feasibility assessment. The instrument validity analysis technique uses Aiken analysis, while the reliability uses PA (Percentage Agreement).

RESULTS AND DISCUSSION

The crystal structure is the initial material taught before the following material in Solid State Physics course. In this material, students are expected to understand the basic concepts of crystal structure, identify problems about crystal system, and perform calculations related to crystal systems. The implementation of the learning begins by providing materials and directions on how to use the Diamond software, whereby before using the software, students will learn about retrieving data on Crystallography Open Database (Rahmawati et al., 2019).

The learning activities are shown in Figure 4. Learning begins by dividing small groups with one laptop for each group. In practice, the teacher will provide an explanation on the examples of the elements to be observed and how to determine the direction and plane of the crystal and the type of crystal structure of the component. In this study, the elements used as examples are Cu and Ni, which have an FCC (Face-Centered Cubic) crystal structure (Parikin et al., 2021; Rosyidan et al., 2022). Next, in practice, students will be asked to examine the results of the data output on the Diamond software and to be able to explain what was obtained. Based on Figure 4, it can be seen that the teacher assisted each group. The final stage in this study is the measurement of the scientific attitude possessed by students and student responses as supporting data. The instruments given were in the form of student scientific attitude questionnaire and student response questionnaire.

Figure 4. Solid State Physics lecture activity using Diamond software

Students' scientific attitude is measured according to 6 (six) aspects of the assessment, namely curiosity, critical thinking, respect for data, perseverance, open-mindedness, and the ability to work together. For the six elements of scientific attitude measured, 23 students, after participating in solid-state physics practicum activities, showed positive results with an average value of 85.83% within the category of high scientific attitude. The complete calculation results of each aspect of the student's scientific attitude are presented in Figure 5. Figure 5 shows the percentage of students' scientific attitudes, namely curiosity by 85%, critical thinking by 80%, respect for data by 87%, persistence by 88%, open minded-ness by 80%, and student cooperation by 95%. Hence, it can be concluded that students' scientific attitude is within the high category.

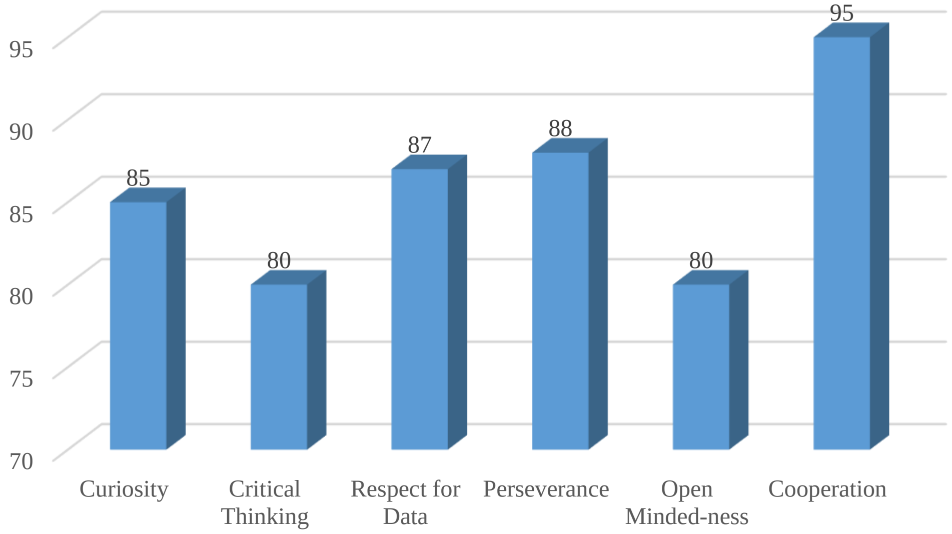

Figure 5. The results of the calculation of each aspect of the student's scientific attitude

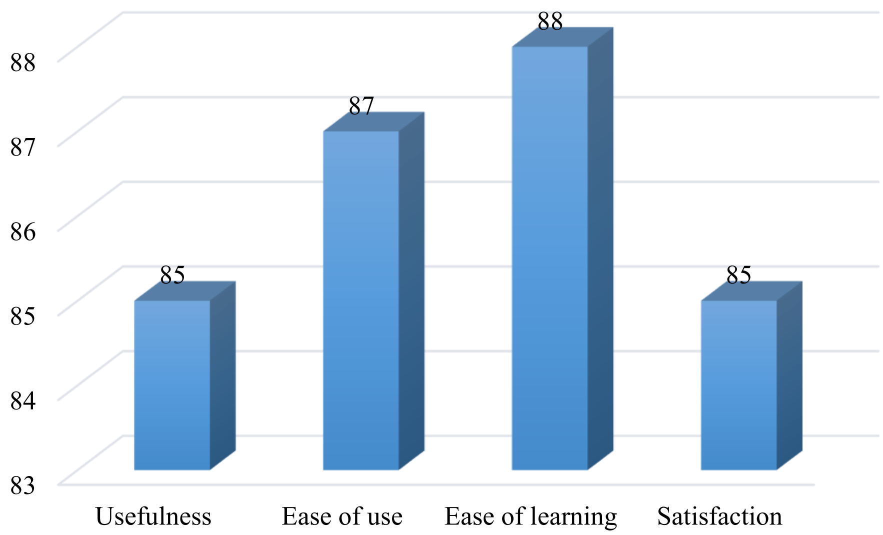

Figure 6. Student response results

The curiosity variable shows that during practicum activities using the Diamond software, many students ask questions about the direction and plane of the crystal and calculate the lattice parameters. This is the first step to form a critical thinking process (Rositawati, 2019). The critical thinking process is developed when students explore data using a crystallographic database and do the matching independently in their respective groups. When other students do not understand how to use data and the process of microstructure analysis, other students in the group will try to assist. This is shown by the percentage of cooperation and open thinking processes. Students' enthusiasm during data analysis and for the objects observed were relatively high. When there is a new idea, the student does not easily accept the idea before proving the truth. Hence, the decision-making process will follow the facts (Shofiyah & Wulandari, 2018). From the observations, it was also found that the process of respecting each other's opinions showed a positive effect, that is, the students don't feel that they are the most correct when there was a similarity for data perception. Hence from this, the teaching and learning process will be more meaningful (Ulfa, 2018; Dewi & Darsinah, 2021). Another supporting observation process is the student response after using the Diamond software showing an average value of 86.25%. They are completely presented in Figure 6.

Figure 6 shows that the percentages of student responses after using the Diamond software in physics are 85% for usefulness, 87% for ease of use, 88% for ease of learning, and 85% for student satisfaction. Hence, it can be concluded that the level of student acceptance is within the high category.

CONCLUSION

The results of the study show that the use of Diamond software in Solid State Physics course could give a positive response, making it easier for students to understand the crystal structure that had been taught without using media. Furthermore, the scientific attitude instrument results show that students have a scientific attitude through the formation of small groups in practicum activities using the Diamond software.

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