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Physics Education Students' Understanding of X-Ray Concepts and Applications: An Interview Study on Stambuk Students 2021

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Abstract: This research aims to explore the understanding of Physics Education students of the class of 2021 regarding the concept and application of X-rays in various fields. Through a qualitative approach with an in-depth interview method, this study involved three participants to gain insight into their understanding of the basic principles of X-rays, the formation process, as well as aspects of radiation safety and risk. The results show that although students have a basic understanding of X-rays as electromagnetic radiation, there are misconceptions about the scope of their application and the principles of physics that underlie the formation of X-rays. The study also found limitations in lecture materials in emphasizing aspects of radiation protection and its applications outside the medical world, which is important to strengthen a comprehensive understanding. Based on these findings, the study provides recommendations to develop a more applicable curriculum, improve practicum facilities, and integrate cross-disciplinary studies so that students have a broader understanding of X-rays.

Keywords: X-Ray, Physics Education, Concept Understanding.

1. INTRODUCTION

Students' understanding of X-ray concepts and applications is one of the important competencies in physics education, especially for those who explore the field of medical physics. X-rays are one of the electromagnetic radiations that have very short wavelengths, with high penetration capabilities, so they are often used in medical diagnostic technologies, such as radiography and tomography. However, the use of X-rays also carries potential risks in the form of radiation exposure that can have a negative impact on the human body (Hidayatullah, 2017). Therefore, a good understanding of X-rays, including their working principles, applications, benefits, and potential impacts, is essential.

X-rays are electromagnetic radiation discovered by Wilhelm Conrad Roentgen in 1895. This technology is widely used in various fields, especially in medicine to support diagnosis and therapy. The process of X-ray formation involves the connection of high-energy electrons using certain materials, producing radiation using wavelengths that can penetrate human body tissues (Aryawijayanti et al., 2015). However, uncontrolled exposure to X-rays can cause serious risks, such as tissue damage and increased risk of cancer due to cell ionization (Hidayatullah, 2017). Therefore, understanding radiation protection is an important aspect of teaching medical physics. Anwar (2011) highlighted the importance of dose control in radiology equipment, while Nugraheni et al. (2022) emphasized the negative impact of radiation exposure when safety protocols are not implemented. These studies are relevant to provide a strong theoretical basis for this research.

Although X-rays have long been an important part of medical technology, several studies have shown that physics education students' level of understanding of this concept is still low. Wardani (2022) in his research said that students often only know X-rays in terms of basic theory without being able to relate them to concrete applications, such as radiation protection or dose control. In addition, (Nugraheni, Anisah, and Susetyo, 2022) emphasized the importance of encouraging

students' awareness of the risks of X-ray images, especially in the context of using radiology equipment. These problems indicate a gap between the theory taught in the classroom and the applicative understanding that students should have. Looking at this challenge, this study aims to explore the understanding of physics education students in the 2021 batch on the concept and application of X-rays. With an in-depth interview approach, this study will analyze the extent to which students know the basic principles of X-rays, including physical phenomena in the process of forming radiographic images, and how they see the impact of X-rays on the human body.

Theoretical studies from previous literature are the main foundation in knowing the context of this problem. Wardani (2022) presented a perspective on students' understanding of the benefits and impacts of X-rays, while Nugraheni et al. (2022) discussed the importance of dose control and radiation protection in X-ray technology applications. This research also seeks to provide relevant recommendations for learning at the university level so that students are able to know and apply the concept of X-rays more comprehensively. The purpose of this study is to identify the level of understanding of physics education students in 2021 on the concept of X-rays, including the underlying physics principles. Analyze students' ability to connect X-ray theory using its application in the field of medical technology. As well as providing recommendations for improving X-ray learning in the physics education study program, especially in the aspects of risk control and practical applications.

The results of this study are expected to provide in-depth insight into the level of understanding of physics education students towards X-rays, both in terms of physics concepts and applications. The findings are also expected to serve as a reference for educational institutions in developing a more applicable curriculum, so that students not only understand the basic theory, but are also able to apply the knowledge to a concrete context. In addition, this research contributes to encouraging students' awareness of the importance of radiation control, so that they can become competent and responsible educators in the future.

2. RESEARCH DESIGN AND METHOD

This research uses a qualitative approach with an interview study method. Rahmat, S, (2009) says Qualitative research is also called naturalistic research. called qualitative because the nature of the data collected is qualitative rather than quantitative because it does not use measuring instruments. called naturalistic because the research field situation is natural or natural, as it is, without being manipulated, arranged using experiments or tests. This approach was chosen to find out in depth the understanding of physics education students of the concept and application of X-rays. Interviews allow researchers to explore students' experiences, knowledge, and perceptions in detail. Interviews are a means of re-checking or proving information or information previously obtained. The interview technique used in qualitative research is in-depth interview. In-depth interview means the process of obtaining information for research purposes using question and answer methods while meeting face to face between the interviewer and the informant or interviewee, with or without using an interview guide, where the interviewer and informant are involved in a relatively long social life. (Rahmat, 2009)

The research was conducted at Medan State University in the Physics Education study program. The research subjects were 2021 students who had taken courses related to modern physics or Quantum physics. The number of research participants was 3 respondents, who were purposively selected according to the criteria of having attended lectures with X-ray material and willing to participate in in-depth interviews. Interviews were conducted face-to-face and lasted 20-25 minutes for each participant. The interviews were recorded with the participants' permission to ensure the data could be analyzed in detail and the results of the analysis were linked using the literature to convey a broader context.

3. RESULT AND DISCUSSION

Based on research by conducting interviews with 3 resource persons (Kaka Level Physics education study program, stambuk 2021), we took 7 points for the interview to find out how their understanding of X-ray material, as for the points we took to find misconceptions of kating through the interview are:

3.1. Basic Understanding of X-rays

Based on the results of the interviews, we see a similar basic understanding of X-rays among the 3 katings who responded that X-rays are a type of electromagnetic radiation that has high energy and can penetrate solid objects, including the human body. The most common use of X-rays is for medical purposes, especially in body imaging such as radiography (x-rays). Their understanding is in accordance with the first discovery of X-rays by Wilhelm Conrad Roentgen in 1895, which opened a revolution in the medical world, especially in detecting health problems through images of the inside of the human body (Nugraheni et al., 2022). However, we found a slight misconception in the answer of the 1st cate who stated that X-rays are only used in hospitals to see the inside of the body, it can trigger misconceptions because it considers X-rays only in hospitals, but actually not only that but can be found as in the industrial field, scientific field, forensics, astronomy and many more.

3.2. Principles of Physics in the Formation of X-rays

On the topic of the physical principles in the formation of X-rays, we found some sentences that lacked detail or precision. All citations mention that X-rays are produced when accelerated high-energy electrons strike a metallic material (such as tungsten), producing X-rays. This is an accurate description of the physical process of X-ray formation. However, the 3rd cating uses the term metal strikes, which is not specific enough and we think may cause confusion. More precisely, the process in question is when high-energy electrons hit a metal anode and cause the release of photons that form X-rays (Hidayatullah, 2017). The explanations of the 1st and 2nd editions are more precise as they mention that X-rays are produced through the sudden stopping of high-energy electrons by the anode metal, which converts some of the kinetic energy of the electrons into X-ray radiation.

3.3. X-ray Applications in Daily Life

From the answers between the three curates to this topic, all of them explained that X-rays have major applications in the medical field, such as for disease diagnosis through body images (such as x-rays or CT scans). They also mentioned X-ray applications in industry for material quality inspection and in security, such as at airports. Similarly, the 3rd kating statement is similar but does not mention in detail applications outside the medical world, such as in material research through X-ray diffraction (XRD), which is one of the important applications in material physics and material engineering (Rani, 2022). Ratings 1 and 2 are more complete by mentioning that X-rays are also used for material quality inspection and public safety at airports and explaining the importance of X-ray use in non-medical fields.

3.4. X-ray Exposure Safety and Risks

Radiation is the emission of energy in the form of waves or particles that are emitted, (Aryawijayanti, R., Susilo, S., & Sutikno, S. 2015). In this topic we recognize that X-rays have risks and require safety, from the results of the interviews all the cats explained that X-ray exposure is a health risk, especially in high doses, which can cause cell and DNA damage and increase the risk of cancer. They also responded that the use of protection such as lead aprons to minimize radiation

exposure is very important. However, it did not provide a more in-depth explanation by explaining that in addition to lead aprons, there are also medical protocols that limit the frequency of examinations and the dose of X-rays to ensure patient safety. Meanwhile, only mentioning the use of lead apron without including further discussion on dose limits or other protocols applied in the use of X-rays (Suyatno et al., 2017).

3.5. *The Role of X-rays in Physics Education*

Based on the answers given, all the catings acknowledged that X-rays are taught in the physics education curriculum, although some of the applicative aspects are considered to be lacking in depth, even adding that discussion of the biological effects of X-rays is often lacking in the materials taught. This is in line with the views expressed by several studies (Wardani, 2022), which show that the topic of X-rays in physics education generally focuses more on the basic principles of electromagnetic waves without too much discussion of their impact on health or their application in various fields. As well as highlighting that the discussion of the health effects of X-rays may need more attention. This is in line with the view that in physics education, discussions about the safety and health effects of X-ray exposure, such as the potential for cancer or genetic disorders, need to be strengthened, given that X-rays are also used in various medical and industrial settings (Tasya & Sudarti, 2022).

3.6. *The Role of X-rays in Modern Physics and Future Careers*

The three katings agree that X-rays have an important role in modern physics, especially in applications in the medical field, atomic structure research, and new materials. It goes on to explain that X-rays are used in molecular structure research and the discovery of new materials through X-ray diffraction, which has contributed greatly to materials science and biotechnology (Sefrilita, 2022). However, Kating 1 only mentions the use of X-rays in medical research, without mentioning its contribution in other fields such as X-ray diffraction used to study atomic structure and materials, which is one of the important applications in modern physics (Mulyono & Subagiada, 2020).

3.7. *X-ray Practicum Experience*

All three ratings mentioned that the X-ray practicum, if conducted, could help deepen understanding of the workings and physical principles of X-rays. Cats 2 and 3 revealed that the practicum also provided insights into radiation safety and dose control techniques, which are very important for reducing potential hazards from radiation exposure in X-ray testing or use (Suhadi et al., 2020).

3.8. *Solutions for Misconceptions and Improved Understanding*

From the results of the analysis, we have conducted above, we have explained various misconceptions, indicating that teaching about X-rays in physics education needs to be improved, both in terms of theory and application. By strengthening students' understanding of the working principles and applications of X-rays, they can become more competent educators and be able to inspire students to explore science-based technologies. To overcome these limitations, several recommendations can be proposed:

- a. Curriculum Development: Add advanced topics on X-rays in the curriculum, including applications and impacts.
- b. Improved Practicum Facilities: Provision of simple laboratory equipment for X-ray simulation can improve students' practical understanding.

Interdisciplinary Integration: Relate X-ray learning to other fields, such as molecular biology or materials engineering, to provide students with greater insight.

4. CONCLUSION

This study shows that Physics Education students in 2021 have a basic understanding of the concept of X-rays, but there are misconceptions in several aspects, such as the scope of its application in various fields and the details of the physical principles underlying the formation of X-rays. In addition, this study identified that the course materials are still lacking in emphasizing aspects of radiation protection and X-ray applications outside the medical field. Based on these findings, it is recommended to develop a more applicable curriculum and provide practicum facilities that support practical understanding. Integration of interdisciplinary studies is also needed so that students can develop a broader and more comprehensive insight into X-ray concepts and applications. The findings are expected to serve as a reference in improving physics learning and helping students apply X-ray concepts in more diverse contexts.

REFERENCES

- Anwar. E. D. 2011. Sistem Proteksi Radiasi: Analisis Terhadap Bidang Radiologi Rumah Sakit. *Jurnal Phenomenon*, 1.
- Aryawijayanti, R., Susilo, S., & Sutikno, S. (2015). Analisis Dampak Radiasi Sinar-X Pada Mencit Melalui Pemetaan Dosis Radiasi Di Laboratorium Fisika Medik. *Indonesian Journal of Mathematics and Natural Sciences*, 38(1), 25-30.
- Hidayatullah, R. (2017). Dampak tingkat radiasi pada tubuh manusia. *Jurnal Mutiara Elektromedik*, 1(1), 24-33.
- Muliyono, S., & Subagiada, K. (2020). Penentuan Nilai Faktor Mesin Pesawat Sinar-X Radiografi Digital Merek Shimadzu di RSUD Dr. Kanujoso Djatiwibowo Balikpapan. *Progressive Physics Journal*, 1(1), 29-39.
- Nugraheni, F., Anisah, F., & Susetyo, G. A. (2022). Analisis Efek Radiasi Sinar-X pada Tubuh Manusia. In *Prosiding SNFA (Seminar Nasional Fisika Dan Aplikasinya)* (Vol. 7, pp. 19-25).
- R, Aryawijayanti, S. S. (2015). Analisis Dampak Radiasi Sinar-X Pada Mencit Melalui Pemetaan Dosis. *Jurnal MIPA*, 38(1), 25-30.
- Rahmat, P. S. (2009). Penelitian Kualitatif. *Equilibrium*, 5(9), 1-8.
- Rani, S. R. A. (2022). Studi Analisis Data Difraksi Sinar-X Pada Material Zircon Pasir Alam Melalui Metode Rietveld. *JFT: Jurnal Fisika dan Terapannya*, 9(1), 16-22.
- Suyatno, F., Yuniarsari, L., & Syawaludin, B. (2017). Perencanaan Prototip Pesawat Sinar-X Diagnosis Berbasis Mikrokontroler. *PRIMA-Aplikasi dan Rekayasa dalam Bidang Iptek Nuklir*, 6(12), 376-380.
- Wardani, T. S. (2022). Analisis Pemahaman Mahasiswa Pendidikan Fisika Universitas Jember terhadap Manfaat Serta Dampak Sinar-X bagi Kesehatan. *Karst: Jurnal Pendidikan Fisika dan Terapannya*, 5(1), 28-38.
- Wiharja, U., & Al Bahar, A. K. (2019). Analisa Uji Kesesuaian Pesawat Sinar-X Radiografi. *Prosiding Semnastek*.
- Yuliamdani, R., Sahara, S., & Fuadi, N. (2020). Pengujian Paparan Radiasi Sinar-X Di Unit Radiologi RSUD Kota Makassar. *JFT: Jurnal Fisika dan Terapannya*, 7(1), 53-61.