37 JPCS 1747

by Nadi Suprapto

Submission date: 08-Apr-2022 09:08AM (UTC+0700)
Submission ID: 1804834557
File name: 37_Suprapto_2021_J._Phys.__Conf._Ser._1747_012015.pdf (825.05K)
Word count: 3042
Character count: 15554

Journal of Physics: Conference Series

Physics education students' understanding of the concept of epistemology, ontology, and axiology

Physics education students' understanding of the concept of epistemology, ontology, and axiology

N Suprapto
Department of Physics, Universitas Negeri Surabaya, Surabaya 60231, INDONESIA
Email: nadisuprapto@unesa.ac.id)

Abstract. One of the studies in the physics education curriculum at the undergraduate level is the philosophy of science (POS). This study aims to analyse the university students' understanding of the concept of epistemology, ontology, and axiology. As the situation of COVID-19 pandemic, an online survey design was utilised in this research. The participants included 89 students who were majoring in Physics Education at a public university in Surabaya Indonesia. In the duration of the Spring Semester 2020, the research was conducted by giving an online test containing statements with a value range of one to ten and a questionnaire with one to five Likert scale. The data obtained were then analysed using quantitative descriptive analysis techniques and an exploratory factor analysis (EFA) to achieve the results of the students' perception of the philosophy of science. The findings indicated it was about 22% of the total participants had a lack of understanding of epistemological studies. Meanwhile, a total of 14.3% of them had a lack of understanding of the concept of ontology. The best result was the understanding of the concept of axiology, the physics education students achieved 91.2% in a good level. Turning to the result of EFA, it stated all items developed to measure the factor behind the structure scale with loading factor more than 0.4 with the overall reliability of more than .80. These findings provide an additional treasure of previous knowledge that rarely explores the concept of epistemology, ontology, and axiology in a specific manner.

1. Introduction

Philosophy of Science (POS) can be understood intensively if the reflection on the History of Science (HOS) has been understood beforehand. POS is a system of thinking that will answer philosophical educational problems and requires philosophical answers as well [1],[2],[3]. POS makes us think critically and creatively in dealing with various problems. The ability to think clearly, to reason logically, and to propose and assess arguments, reject assumptions that are taken for granted, and a search for coherent principles of thought and action — all of these are characteristics of the results of practice in POS. Learning the philosophy of science for university students is very important, because of the several benefits that can be felt [2-5].

The first benefit of learning POS is students are expected to be more critical in their scientific attitude. Students as campus people are expected to be critical of the various theories, they learn in the lecture hall and from other sources. Studying the philosophy of science is of use to students as prospective scientists to explore the scientific method and to carry out scientific research as the second benefit. By studying the philosophy of science, it is hoped that they will have a complete understanding of science and be able to use this knowledge as a foundation in the learning process and scientific research [1-2].

Studying the philosophy of science has also practical benefits. After students graduate and work, they must be faced with various problems in their work. To solve the problem requires critical thinking skills in analysing various things related to the problem at hand. In this context that the experience of studying the philosophy of science is applied. Moreover, through POS, it gets used to being logical-rational in the opinions and arguments presented and developing a spirit of tolerance in terms of different views (plurality) [1]. Because the philosophers have never had one opinion, both in content, formulation of problems and preparation of answers [2]. POS has also taught careful and tireless thinking. The three foundation issues in POS are studying about epistemology, ontology, and axiology. Therefore, the effort in exploring students' understanding of these concepts is useful for lecturer or faculty member.

In order to make the research more focused, then the following are the research questions:

a) To what extent do the university students' profile of understanding of the concept of epistemology, ontology, and axiology?
b) To what extent do the Philosophy of Science (POS) scale in exploring university students' perception of the concept of epistemology, ontology, and axiology?

2. Method

This research utilises a survey design [6-7]. As the situation of COVID-19 pandemic, an online survey design was utilised in this research. The participants included 89 students who were majoring in Physics Education at a public university in Surabaya Indonesia. In the duration of the spring semester 2020, this research was conducted by giving an online test containing statements with a value range of one to ten and an online questionnaire with one to five Likert scale. The greater value given indicates the level of confidence of respondents on the truth of the statement. The first step was determining the item under the study of the POS, especially in the theme of epistemology, axiology, and ontology. Next, the step was making a revision of the statement or item after receive suggestions from colleagues. Then, create a questionnaire using Google Form to further expert validation. Finally, 30 items of the test and 10 items of questionnaire were ready to be distributed to students to determine the level of student understanding of those three concepts. The data obtained were then analysed using quantitative descriptive analysis techniques to explore the students understanding on POS and exploratory factor analysis (EFA) to achieve the results of the students' perception of the philosophy of the concept of science.

3. Results and Discussion

At the first step, the author provides the trend and the novelty of research on philosophy of science. Figure 1. illustrates the network visualisation performed by *VOSviewer* based on Scopus database regarding Philosophy of Science with three main issues: epistemology, ontology, and axiology. The advanced search as key words used was:

"epistemology AND ontology AND axiology OR philosophy AND of AND science AND (LIMIT-TO (DOCTYPE, "ar")) AND (LIMIT-TO (SUBJAREA, "SOCI"))" with the domain of science education.

From Figure 1., it is clear that the dominance of term 'epistemology' as part of philosophy of science. On the other hand, the term 'ontology' and 'axiology' integrates or emerges with another term in published articles based on Scopus database. It means a few studies of ontology and axiology in the domain of science education.

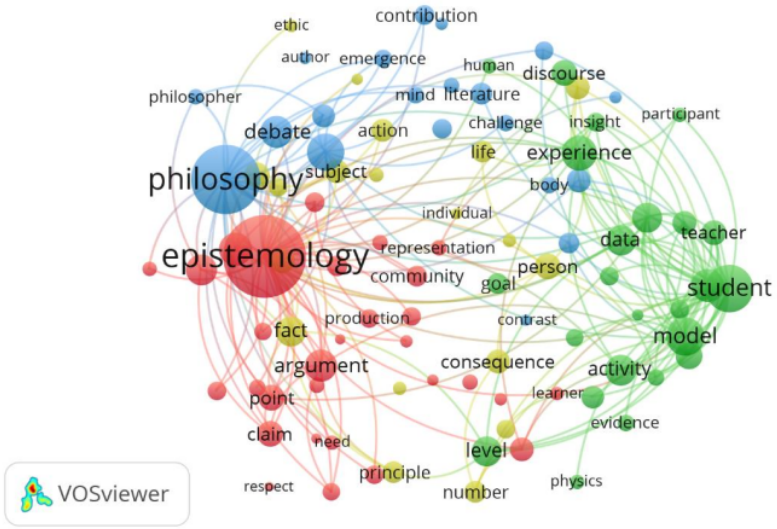


Figure 1. A network visualisation based on Scopus database regarding Philosophy of Science.

a) To what extent do the university students' profile of understanding of the concept of epistemology, ontology, and axiology?

Before this paper explores the answer of the first research question, the next discussion is the explanation of the main issues in philosophy of science. The term "epistemology" comes from the Greek words' "episteme" and "logos" [8]. "Episteme" can be interpreted as "knowledge" or "understanding", while "logos" can be decoded as "reason" or "argument" [8]. Currently, epistemology is "an attempt to understand how our degrees of confidence are rationally constrained by our evidence or an attempt to understand the ways in which interests affect our evidence, and affect our rational constraints more generally" [8]. It pursues to comprehend one kind of cognitive *success* or cognitive *failure*. Meanwhile, ontology is "the study of what there is" [1,2]. Ontology is "usually also taken to encompass problems about the most general features and relations of the entities which do exist" [8]. There are at least two parts to the philosophical activities of ontology: (1) say what there is, what exists, what the stuff is reality is made out of, and (2) say what the most general features and relations of these things are [1,8,12,14]. On the other hand, axiology is related to "value theory". In this narrow sense, this theory is roughly synonymous with "axiology". Axiology can be supposed of as primarily concerned with classifying what things are good, and how good they are [1,2,8,12,14]. The "value theory" entitles the area of moral philosophy that is focused on the theoretical questions about value and goodness of all varieties. The axiology incorporates many questions about the nature of value and its relation to moral categories [1,2,8,10,12,14].

Figure 2. depicts the students' understanding on the concept of epistemology. As a mention previously, epistemology is a science that discusses in depth the entire process of arranging correct knowledge [5]. Based on these data, it can be seen that as many as 22% of the number of undergraduate physics students have a less understanding level of epistemological studies and as many as 78% of the number of them have a good level of understanding of epistemological studies where the percentage is assumed that a value of 1-5 indicates that students do not understand epistemological studies and values. Then, a score with 6-10 shows that students already recognise epistemological studies. From the graph, many students agreed that before the emergence of scientists, the concept of physics was applied in society even though people did not realise that what they were doing was the application of the concept of physics. Students have also agreed that the history of physics has developed from time to time, so that it can affect the human mindset towards the development of physics.

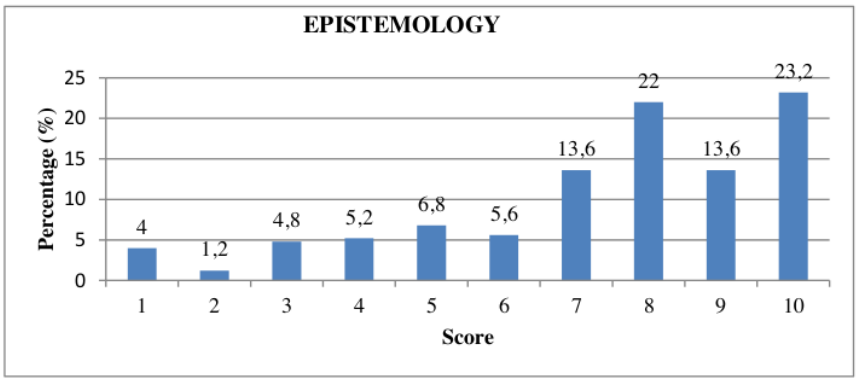


Figure 2. Students' understanding on the concept of epistemology

Figure 3 illustrates how ontology as a branch of POS that investigates this real world and how it actually is. It can be seen that as many as 91.2% of the students have a good level of understanding of axiological studies, while 8.8% of the students have a low level of understanding.

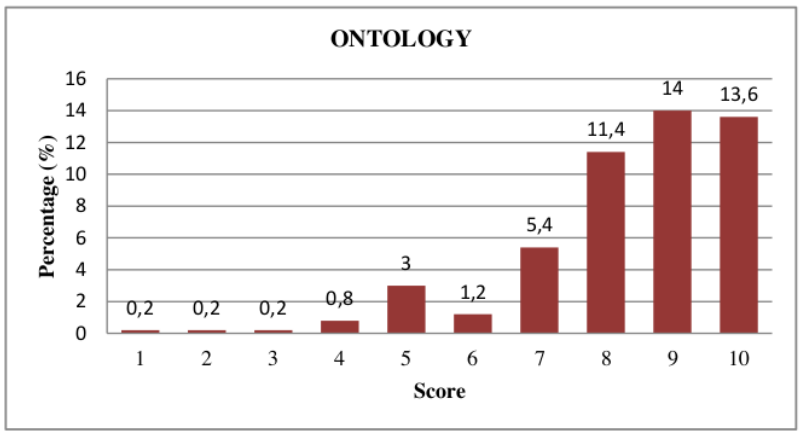
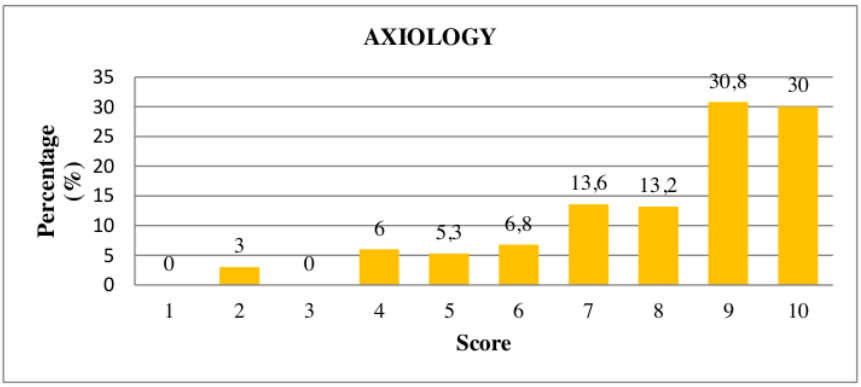


Figure 3. Students' understanding on the concept of ontology

Axiology focuses on the investigating of the nature of values from a philosophical point of view. Based on Figure 4, it can be seen that 94.4% of the physics students have a good level of understanding of axiological studies, while 14.3% of the respondents have a lack of understanding of axiological studies. Where, it is noted that score 1-5 indicate that students do not understand axiological studies and scores 6-10 indicate students already understand axiological studies.

From the Figure 4, many students agreed that the concept of physics comes from everyday life so that the concept of physics exists to explain problems in everyday life. In addition, students have also agreed that human needs are based on the development of physics. This is proven through the application of physics which can change the role of humans in current technological developments. Therefore, humans realise that the development of physics is based on human needs.

Figure 4. Students' understanding on the concept of axiology



b) To what extent do the Philosophy of Science (POS) scale in exploring university students' perception of the concept of epistemology, ontology, and axiology?

Based on the ten Philosophy of Science scale provided, the reliability of the instrument reach .809 with Cronbach's alpha criteria. It means the scale fulfil the criteria of reliability [9,11,13]. Meanwhile, the results of Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Test is also depicted on Table 1. Since the value of KMO is greater than 0.6 dan the Bartlett's test is significant then these results are available for exploratory factor analysis (EFA) [9,11,13].

Table 1. KMO and Bartlett's Test.

"Kaiser-Meyer-Olkin Measure of Sampling Adequacy".		.767
"Bartlett's Test of Sphericity"	Approx. Chi-Square	263.521
	df	45
	Sig.	.000

Meanwhile, among ten items extracted three factors with variance explained 62.55%. The illustration of scree plot with a minimum eigen value (=1) of each factor is illustrated on the Figure 5.

Figure 5. A scree plot of POS scale.

As part of empirical validation of the scale, a loading factor is used in performing to what extent do each item valid or not. Based on Table 2, all items accounted loading factors greater than 0.4 as a minimum requirement in EFA [9,11,13] and it indicated valid items. Thus, for the research question (RQ2) it can be concluded that the POS scale fulfilled the criteria of validity and reliability from the results of Cronbach's alpha and EFA.

Table 2. Loading factor after Rotated Component Matrix.

Item (see Appendix)	Loading Factor (F=62.55%)		
	F1 (28.322%)	F2 (20.105%)	F3 (14.124%)
g	**.839**		
h	**.694**		
f	**.680**		
a	**.660**		
d	**.646**		
i	**.461**	.402	
b		**.825**	
c		**.820**	
j			**.890**
e		.519	**.632**

Extraction Method: PCA.
Rotation Method: Varimax with Kaiser Normalization.

4. Conclusion

The findings of the research indicated that it was about 22% of the total participants had a lack of understanding of epistemological studies. Meanwhile, a total of 14.3% of the respondents had a lack of understanding of the concept of ontology. The best result was the understanding of the concept of axiology, while the undergraduate physics students achieved 91.2% had a good level of understanding of this concept. It indicated that 8.8% of them had a low level of knowledge of axiological studies. Turning to the result of EFA, it stated all items developed to measure the factor behind the structure scale with loading factor more than 0.4 with the overall reliability of more than 0.8. It was noted that the scale explained the variance of 62.55%. All the results of EFA fulfilled the statistic criteria. This finding provides an additional treasure of previous knowledge that rarely explores the concept of epistemology, ontology, and axiology in a specific manner. It can be

concluded that the majority of undergraduate physics students know and understand the fundamental concept of philosophy of science with ranked axiology, ontology, and epistemology. The results of EFA claimed the questionnaire had been used fulfilled the requirement of validity and reliability of a scale.

References

[1] Yafeng S 2020 *Doing Integrated History and Philosophy of Science: A Case Study of the Origin of Genetics* (New York: Springer)
[2] Nola R and Irzik G 2005 *Philosophy, Science, Education and Culture* (New York: Springer)
[3] Suprapto N, Mubarok H and Adam A S 2019 *J. Phys.: Conf. Ser.* **1417** 012073
[4] Suprapto N, Deta U A, Lestari N A, Kholiq A, Adam A S, Mubarok H and Jauhariyah M N R 2018 *J. Phys.: Conf. Ser.* **1108** 012097
[5] Suliyanah, Suprapto N, Mubarok H, Adam A S and Sunarti T 2019 *J. Phys.: Conf. Ser.* **1351** 012061
[6] Creswell J W 2012 *Educational Research: Planning, Conducting, and Evaluating (Quantitative and Qualitative Research), 4th ed.* (Boston, MA: Pearson)
[7] Creswell J W and Plano C V 2011 *Designing and Conducting Mixed Methods Research, 2nd Ed.* (Thousand Oaks, CA: Sage)
[8] Steup M 2005 *Stanford Encyclopedia of Philosophy*. Retrieved from https://plato.stanford.edu/entries/epistemology/
[9] Suprapto N 2019 *J. Phys.: Conf. Ser.* **1171** 012003
[10] Vyzhletsov G P 2017 *Vestnik Sankt-Peterburgskogo Universiteta, Filosofiia i Konfliktologiia* **33** 275
[11] Suprapto N 2019 *Int. J. Instruction* **12** 242
[12] Swan M and de Filippi P 2017 *Metaphilosophy* **48** 603
[13] Suprapto N, Saragih O K and Al Ardha M A 2019 *J. Int. Students* **9** 613
[14] Hothersall S J 2019 *European J. Social Work* **22** 860

Appendix (Scale)

a) There are three basic foundations that must be fulfilled in the philosophy of science: epistemology, ontology, and axiology.
b) Positivists claimed that a scientific theory could be expressed in the formal language of mathematical logic.
c) Scientific explanation becomes the formal deduction of observed phenomena from general laws.
d) Kuhn paradigm establishes a period of scientific practice known as normal science.
e) Instrumentalists claim that the value of a scientific theory depends only on its ability to predict and model.
f) Realists claim that its value also depends on the degree to which the theory depicts the way things really are.
g) Deductive reasoning is a reasoning that stems from a general event, the truth of which is known or believed, and ends in a conclusion or new knowledge that is more specific.
h) Inductive reasoning starts with a statement or special circumstances and ends with a general statement.
i) Various argumentation models such as Socrates, Toulmin strongly support the birth of normal science.
j) Philosophy of science invites us to think and reason in distinguishing between pseudoscience and science.

37 JPCS 1747

ORIGINALITY REPORT

14%	11%	4%	10%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	solarnano.files.wordpress.com Internet Source	2%
2	api.philpapers.org Internet Source	1%
3	sites.google.com Internet Source	1%
4	Submitted to Fakultas Hukum Universitas Lampung Student Paper	1%
5	N Suprapto. "Demographic sources as a local wisdom: Potency of Indonesian physics education researchers in conducting survey research", Journal of Physics: Conference Series, 2019 Publication	1%
6	Submitted to Midlands State University Student Paper	1%
7	Submitted to Albany State University Student Paper	1%

8	www.coursehero.com Internet Source	1 %
9	Submitted to University of Strathclyde Student Paper	1 %
10	Usir.Salford.Ac.Uk Internet Source	<1 %
11	citeseerx.ist.psu.edu Internet Source	<1 %
12	repository.usd.ac.id Internet Source	<1 %
13	Submitted to Kwame Nkrumah University of Science and Technology Student Paper	<1 %
14	Submitted to Stadio Holdings Student Paper	<1 %
15	docplayer.net Internet Source	<1 %
16	edtechbooks.org Internet Source	<1 %
17	journal.ucc.edu.gh Internet Source	<1 %
18	www.saibw.co.za Internet Source	<1 %
19	dspace.nwu.ac.za	

	Internet Source	<1%
20	udsspace.uds.edu.gh Internet Source	<1%
21	www.lingcure.org Internet Source	<1%
22	stanford.library.sydney.edu.au Internet Source	<1%

Exclude quotes	On	Exclude matches	< 3 words
Exclude bibliography	On		