**Research Article**

# An exploration of teachers' epistemological belief: A case from in-service and pre-service physics teachers in Bengkulu

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**Abstract.**
Epistemological belief is a belief, knowledge, and coaching value that is useful for creating a student learning environment to increase the belief and value system towards knowledge, learning, and teaching. However, there is a few explorations in the context of in-service and pre-service physics teacher. The aim of this study is to explore the epistemological beliefs of in-service and pre-service physics teachers based on their time period in teaching experience. This study used a mixed-method with a model explanatory sequential design. The quantitative data were collected through science epistemological belief questionnaires (n = 23) and the qualitative data were collected through interviews with teachers (n = 6) about their epistemological beliefs. Data were analyzed through descriptive statistic and a content analysis. The result from the quantitative data is that epistemological beliefs of in-service and preserving physics teachers are in a good category and the qualitative data showed that most of the in-service and pre-service teachers have epistemological beliefs on the transitional and instructive levels. The findings of this study can be considered in developing the teacher's professionalism to have better physics classroom teaching and learning practice.

**Keywords:** Epistemological Belief Physics Education In-service Teacher Pre-service Teacher

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# 1. INTRODUCTION

The development of a country can be improved by having quality human resources. In order for the new generation to have quality, the existing education system must be reorganized taking into account current and future needs [1]. With changing conditions, changes in the education system and the role of teachers in this system also occur. At this time, in-service and pre-service teachers need $21^{st}$ century skills to create a teaching and learning environment that suits today's needs. In this case, in-service and pre-service teachers have the responsibility and the influence of students development with $21^{st}$ century skills, because teachers spend a lot of time with students while they are studying [2].

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During the learning process students have attitudes, beliefs, and expectations towards the material being taught, for example in learning physics, the process of interaction between teachers and students can affect the way they work and behave [3]. For example, the common belief of students is that physics consists of some unrelated information. As a result, many students study physics by memorizing formulas without relating them to a broader understanding of the underlying concepts and principles. An important aspect of student learning and achievement is their epistemological beliefs. Epistemological beliefs (EB) are assumptions made about the nature of knowledge and the acquisition of knowledge [4].

In addition, instructional decisions and classroom interactions created by teachers also affect students' beliefs and attitudes towards learning physics [5]. Thus, the teacher's beliefs directly affect their behavior and teaching/learning process [6]. When examining the nature of beliefs, teachers' beliefs are viewed as a system [7]. These beliefs in this system are interconnected and work together. Among these beliefs, epistemological and pedagogical beliefs develop over a long period of time, have a central position, and are difficult to change [8]. Epistemology is a branch of philosophy that seeks to answer the question of what is meant by knowledge, and how knowledge is obtained [9], [10].

Epistemology is a key component of philosophy, concerned with the nature and scope of knowledge, and is described as "an individual's personal beliefs about the structure of knowledge, the stability of knowledge, and the sources of knowledge" [11]. Marlene Schommer [12] suggests a multidimensional approach in which a person who develops certain dimensions of epistemological beliefs may or may not develop other dimensions. Five dimensions of epistemological beliefs hypothesized by Schommer [12]: certainty of knowledge, simplicity of knowledge, innate ability of knowledge acquisition, speed of knowledge acquisition, and omniscient authority.

Within this scope, Personal Epistemology stems from the finding that so-called complex epistemological beliefs are often associated with better learning outcomes than "naive" epistemological beliefs [13]–[15]. Schommer [12] highlights that individuals with naive Personal Epistemological Beliefs (PEB) assume that knowledge is simple and learning depends on individual abilities, while individuals with complex PEB generally believe that knowledge is always changing, complex, tentative, and learning is built on their effort. PEB is an important aspect of the coaching process, as it requires continuously adopting and applying different types of knowledge and skills in a successful learning process [16].

Epistemology has been noted as the foundation for providing and enabling teachers to build their own knowledge, beliefs, and values [17]. Beliefs in knowledge and learning are the beginning of the interrelated decisions that are made to create a learning environment for students, so that beliefs and systems value towards knowledge, teaching, and learning [18]. Learning effectiveness is defined as the application of professional and interpersonal knowledge to improve students' connections, character, self-confidence, and competence [19]. In addition, Côté and Gilbert [19] also show that knowledge structure is associated with expertise and effectiveness in learning contexts. PEB and ongoing decisions made based on these epistemological beliefs are described as an epistemological chain and previously stated as a reflection of the experiences and attitudes of teachers [20]. The epistemological chain will help teachers to "practice a useful framework for assessing their own and others' actions and behavior" and allow teachers to optimally apply new ideas in their own learning and can be used to direct the search for new learning knowledge [21]. This effect can more or less occur when EB is used as standards that can be used to assess the ability and trustworthiness of the information to be studied [22]. Based on the results of research from Gutierrez [23] the epistemological views of teachers and students, and found that there is a close relationship between the two.

Research conducted by Bayraktar [24] conducted on prospective elementary school teachers in science learning suggests that EB has an important effect on student learning, more detailed research on sources of belief can be useful for finding ways to increase student confidence. In addition, students' EB will also change from time to time due to being influenced by several things, one of which is the way the teacher teaches. This strengthens the researchers' confidence to reveal more about the EB of in-service and pre-service physics teachers. Furthermore, a study conducted by Kirmizigul [25] conducted on prospective science teachers found that each individual's EB is at a different level of development for each category. Therefore, EB should not be neglected in establishing and developing programs, and in determining classroom activities. In this study, it is also recommended to conduct further research using two (qualitative and quantitative) research instruments in order to reveal more deeply what factors influence the development of EB. In line with what is suggested by this study, we want to explore the EB of in-service and pre-service physics teachers. We believe that it is important to examine the EB of in-service and pre-service physics teachers for making physics teaching effective in their future classrooms.

## 2. METHOD

### 2.1. Design

The research method used in this research is explanatory sequential design. The purpose of this explanatory sequential mixed method research is to investigate the teachers' epistemological beliefs of in-service and pre-service physics teachers in Bengkulu. Data were collected through a questionnaire and interviews. The instruments on this study were adapted from the previous studies as follow : (a) epistemological belief questionnaires [26] and the interview guideline which was developed by Luft [27]. The design in this study consists of two phases (see Figure 2) as follows : (a) data collection and analysis of questionnaires (i.e., quantitative data), and interviews (i.e., qualitative data) based on the result from the questionnaire [28]. This methodology is in accordance with this study because the researcher seeks to understand the various perceptions of the research sample regarding epistemological beliefs.
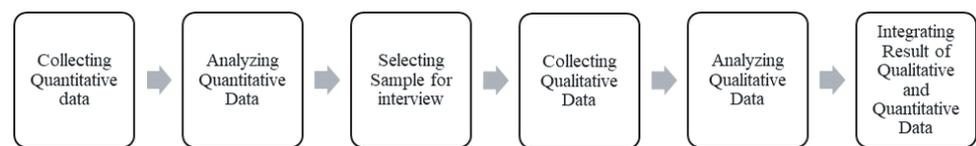


**Figure** 1: Visual display for the explanatory sequential study design procedure.

### 2.2. Context of study

The research will be conducted on 23 in-service and pre-service physics teachers who will be asked to fill out a questionnaire regarding epistemological beliefs and 6 in-service and pre-service physics teachers in Bengkulu Province will be selected for in-depth interviews related to epistemological beliefs. The research subjects who were interviewed were selected based on the result of the questionnaire. The criteria for teachers to be used as research subjects for interviews were two physics teachers who have more than 10 years of teaching experience, two physics teachers who have 3-9 years of teaching experience, and two in-service or pre-service physics teachers with 0-2 years of teaching experience.

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## 2.3. Data analysis

Descriptive statistical analysis was conducted on 37 items questionnaires. Meanwhile, for the interviews data, we used the content analysis for seven interview questions. We analyzed the interview data through a priori coding technique which refers to the framework used in this study. The example of categories in the interview data can be seen in Table 1.

# 3. RESULT AND DISCUSSION

## 3.1. Quantitative result

This study used descriptive statistical analysis to explain the result of epistemological beliefs questionnaire. The descriptive analysis presented in Table 2 that in-service and pre-service physics teachers' responses could be grouped into seven scales, that is speed of knowledge (9 items), successful student (4 items), certain and truth (3 items), construction and modification (5 items), source/authority (3 items), simplicity (7 items), and structure of knowledge (6 items). We performed the analysis by showing the participants' category of epistemological beliefs. The analysis was done by calculating each participant's responses to the questions in the questionnaire. The total score of each of the participants showed their category of epistemological beliefs.

The result of epistemological beliefs questionnaire revealed that the EB's categories among 23 participants were determined by calculating the average of each item in each aspect of EB questionnaire and the final conclusion was determined from the average number of each aspect. The quality category of the response could be grouped into five categories as follows: very poor (0% - 20%), poor (21% - 40%), fair (41% - 60%), good (61% - 80%), and excellent (81% - 100%).

The descriptive statistic presents the percentage of mean score based on aspect in questionnaires. The use of descriptive statistics helped the researcher to meaningfully describe and summarize the data, which consisted of 37 items and 7 aspects (Table 2). We found that participants scored high in aspect simplicity (78,8 %) and low in aspect speed of knowledge acquisition (66,3 %). Speed of knowledge acquisition implies perception of the time it takes for learning to occur (e.g., "if I try to integrate new ideas in physics textbook with knowledge that I already have about a topic, I will just get confused"). For the aspect successful students implied views about learning as a result of an innate ability or due to time and effort (e.g., "successful students in

Table 1: The relationship between sub-categories data, dimension of the framework.

| Category | View on Science | 0-2 Years Teaching Experiences | 3-9 Years Teaching Experiences | More than 10 Years Teaching Experiences |
|---|---|---|---|---|
| **Traditional** | **Science as a role or fact** | I maximize students learning by carefully planning my lessons based on the indicator and goals in learning | I maximize students learning by using media like text book or e-book because media can help student to understand about 80% of successful in learning | I decide what to teach and what not to teach based on time and limited by the national curriculum |
| **Instructive** | | I know when my students understand when they can answer on the quizzes and the answer is correct | I decide to move on to a new topic in my class when I feel like students get it and when we have covered the material | I decide to move on to a new topic in my class when students pass the quizzes or exam in the end of our chapter, and we run out of time. |
| **Transitional** | **Science as consistent connected and object** | Learning process is occurring in my class when there is a mutual interaction teacher and students about the material | The best way for learning physics is by doing a laboratory activity and by knowing their capability to solve a physics problem | Learning process is occurring in my class when the students are actively engaged in learning rather than passive recipients of information, and they are ready to learn. |
| **Responsive** | **Science as a dynamic structure in a social and cultural context** | - | - | My students learn physics best, firstly, student should have good literacy, and secondly, student should try to do the experiment what they have learned, so they must be creative how to arrange a good work of science. |
| **Reform-based** | | - | - | I am a facilitator for my students, so student can get deeply information by them selves then teacher maximize what they know using a discussion |

physics understand things quickly"). Meanwhile, for the aspect certain and truth means beliefs about knowledge as absolute or not (e.g., "physics is based on certainties that will most likely not change overtime"). Then, construction and modification refer to belief about knowledge as constructed and modified through strategies (e.g., "when learning physics, the most important thing is to think creatively"). The next aspect is

<span>T</span>ABLE 2: Questionnaire result.

| Aspect | Mean | Standard Deviation | Percentage | Category |
|---|---|---|---|---|
| Speed of knowledge acquisition | 29,65 | 4,007 | 66,3 % | Good |
| Successful student | 13,39 | 2,589 | 66,5 % | Good |
| Certain and truth | 10,17 | 1,850 | 67,5 % | Good |
| Construction and modification | 18,17 | 2,146 | 73,2 % | Good |
| Source / authority | 11,57 | 1,237 | 75,7 % | Good |
| Simplicity | 24,74 | 1,912 | 78,8 % | Good |
| Structure of knowledge | 20,70 | 2,458 | 69,3 % | Good |
| Overall | 128,39 | 11,448 | 71 % | Good |

source/authority that implies the relationship between teachers and teachers or teachers with students (e.g., "when I encounter a difficult physics concept in a textbook, I ask to other physics teacher"). In addition, for the aspect simplicity, it refers to the pattern between studies and significant relationship with students' achievement and behavior during learning (e.g., "to know physics, I need to understand how the different things we learn in physics are related"). Then, the last aspect of EB is structure of knowledge that implies belief about knowledge as integrated or not (e.g., "the best thing about physics course is that there is only one correct way to solve the problems"). Overall, the result of this study showed that the epistemological beliefs held by in-service and pre-service physics teacher were in the good category. This finding strengthen the previous study that the EB of teachers are in the various categories Kirmizigul [25]. From here, we can see that the level of EB from our participants are enrich the knowledge base in this field.

## 3.2. Qualitative result

This study used a priori coding technique to explain the result of teacher EB's interview. Interviews were used to get a more in-depth explanation of the results of the questionnaires that had been conducted previously so that it could strengthen the results. The distribution of a priori coding presented in Figure ??. It showed that in-service and pre-service physics teachers' responses could be grouped based on their teaching experience.

Based on Figure ??. Most of In-service and pre-service physics teachers (0-2 years) has epistemological beliefs in instructive category. It means that they teach physics with focus on providing experiences, teacher-focus, or teacher decision. For example,
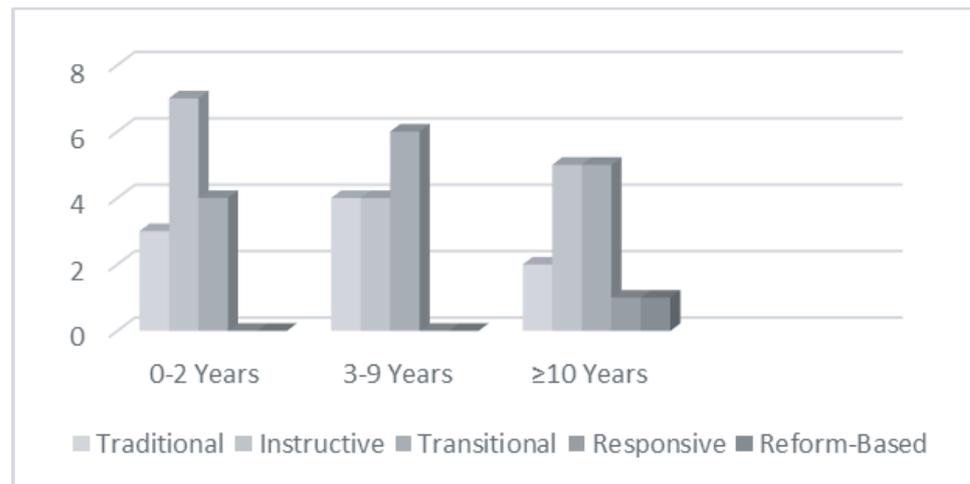
**Figure** 2: Profile epistemological belief of physics teachers.

teacher wants to provide students with experiences in laboratory (no elaboration). Most of teachers with 3-9 years teaching experiences has transitional category on epistemological beliefs. It shows that the participants teach physics with focus on teacher/student relationships, subject decisions, or affective response. For example, teacher is responsible to guide students in their development of understanding and process skills. Then, most of teachers with 10 years or more teaching experiences has EB in instructive and transitional category, but the different is that they have EB in responsive and reform-based category. That indicates some teachers with 10 years or more teaching experiences have experienced improvements in teaching methods by paying more attention to the needs of students. Responsive category means teachers focus on collaboration, feedback, or knowledge development. For example, teacher wants to set up his classroom so that students can take charge of their own learning. Reform-based category implies that teachers focus on mediating students' knowledge or interaction. We can see that the teacher's role is to provide students with experiences in science that allow teachers to understand students' knowledge and how students understand physics. Teacher instructions need to be modified in such a way that students understand key concepts in physics. This findings are in line with the result from the study by Bayraktar [24] that the teachers' view through their EB has important contribution to students' learning and confidence. Teacher instructions need to be modified in such a way that students understand key concepts in physics.

# 4. CONCLUSION

Epistemological beliefs (EB) of in-service and pre-service physics teachers are in a good category and most of them are in instructional beliefs which are more likely to move toward transitional dispositions. Understanding the beliefs of teachers is critical if those of physics teacher education are going to develop programs that have a lasting impact on teachers.

In conducting this study, we acknowledge the limitation of our study. Firstly, we need more participants to have more comprehensive results which can represent the condition all physics teachers in Bengkulu. Secondly, we need to include private schools as the participant which might differently views regarding EB since we involved the public schools in this study. Lastly, we also suggest to use several ways that can be done to collect the data. The researcher can examine using different times through a longitudinal study to see the development of EB's physics teachers. Also, we can expand the data collection to multiple interviews and different geographic areas for the future studies.

This study implies that there may be differences in the level of EB in teachers who teach in public, private, vocational schools or pre-service teachers studying at public and private universities. Therefore, this provides opportunities to conduct more research in this area.

# References

[1] A. KULOĞLU and V. Karabekmez, "The Relationship Between 21st-century Teacher Skills and Critical Thinking Skills of Classroom Teacher," *Int. J. Psychol. Educ. Stud.*, vol. 9, no. 1, pp. 91–101, 2022.

[2] A. S. Akdemir, "A history of teacher training programmes and their problems in Turkey," *Turk. Stud.-Int. Period. Lang. Lit. Hist. Turk. Turk.*, vol. 8, no. 12, pp. 15–28, 2013.

[3] K. K. Perkins, W. K. Adams, S. J. Pollock, N. D. Finkelstein, and C. E. Wieman, "Correlating student beliefs with student learning using the Colorado Learning Attitudes about Science Survey," in *AIP Conference Proceedings*, 2005, vol. 790, no. 1, pp. 61–64.

[4] L. Reddy, "An Evaluation of Undergraduate South African Physics Students' Epistemological Beliefs When Solving Physics Problems.," *EURASIA J. Math. Sci. Technol. Educ.*, vol. 16, no. 5, 2020.

[5] J. L. Docktor and J. P. Mestre, "Synthesis of discipline-based education research in physics," *Phys. Rev. Spec. Top. - Phys. Educ. Res.*, vol. 10, no. 2, p. 020119, Sep. 2014, doi: 10.1103/PhysRevSTPER.10.020119.

[6] N. T. Önal and A. S. Kirmizigül, "Investigation of the Preservice Teachers' Science-Pseudoscience Distinction and Epistemological Beliefs.," *J. Pedagog. Res.*, vol. 5, no. 3, pp. 55–67, 2021.

[7] H. Fives and M. M. Buehl, "Spring cleaning for the 'messy' construct of teachers' beliefs: What are they? Which have been examined? What can they tell us?," 2012.

[8] A. Kilinc, U. Demiral, and T. Kartal, "Resistance to dialogic discourse in SSI teaching: The effects of an argumentation⬚based workshop, teaching practicum, and induction on a preservice science teacher," *J. Res. Sci. Teach.*, vol. 54, no. 6, pp. 764–789, 2017.

[9] B. K. Hofer and L. D. Bendixen, "Personal epistemology: Theory, research, and future directions.," 2012.

[10] M. S. Topcu, "PRESERVICE TEACHERS'EPISTEMOLOGICAL BELIEFS IN PHYSICS, CHEMISTRY, AND BIOLOGY: A MIXED STUDY," *Int. J. Sci. Math. Educ.*, vol. 11, no. 2, pp. 433–458, 2013.

[11] M. Schommer-Aikins, "Explaining the epistemological belief system: Introducing the embedded systemic model and coordinated research approach," *Educ. Psychol.*, vol. 39, no. 1, pp. 19–29, 2004.

[12] M. Schommer, "Effects of beliefs about the nature of knowledge on comprehension.," *J. Educ. Psychol.*, vol. 82, no. 3, p. 498, 1990.

[13] K. R. Muis, "Personal epistemology and mathematics: A critical review and synthesis of research," *Rev. Educ. Res.*, vol. 74, no. 3, pp. 317–377, 2004.

[14] S. Pieschl, E. Stahl, and R. Bromme, "Epistemological beliefs and self-regulated learning with hypertext," *Metacognition Learn.*, vol. 3, no. 1, pp. 17–37, 2008.

[15] U. Trautwein and O. Lüdtke, "Epistemological beliefs, school achievement, and college major: A large-scale longitudinal study on the impact of certainty beliefs," *Contemp. Educ. Psychol.*, vol. 32, no. 3, pp. 348–366, 2007.

[16] C. J. Cushion, K. M. Armour, and R. L. Jones, "Coach education and continuing professional development: Experience and learning to coach," *Quest*, vol. 55, no. 3, pp. 215–230, 2003.

[17] A. Abraham and D. Collins, "Examining and extending research in coach development," *Quest*, vol. 50, no. 1, pp. 59–79, 1998.

[18] D. Grecic, "Back to Front Coach Learning-Reflections on the final study: Epistemological Chaining across the Talent Pathway," *J. Qual. Res. Sports Stud.*, vol. 9, no. 1, pp. 235–256, 2015.

[19] J. Côté and W. Gilbert, "An integrative definition of coaching effectiveness and expertise," *Int. J. Sports Sci. Coach.*, vol. 4, no. 3, pp. 307–323, 2009.

[20] D. Grecic and D. J. Collins, "A qualitative investigation of elite golf coaches knowledge and the epistemological chain," *J. Qual. Res. Sport Stud.*, vol. 6, no. 1, pp. 49–70, 2012.

[21] D. Grecic and D. Collins, "The epistemological chain: Practical applications in sports," *Quest*, vol. 65, no. 2, pp. 151–168, 2013.

[22] T. Richter and S. Schmid, "Epistemological beliefs and epistemic strategies in self-regulated learning," *Metacognition Learn.*, vol. 5, no. 1, pp. 47–65, 2010.

[23] R. Gutierrez, "Epistemological and ontological aspects in Science Teacher Education," *Qual. Dev. Teach. Educ. Train.*, vol. 48, 2004.

[24] S. Bayraktar, "Pre-Service Primary School Teachers' Scientific Epistemological Beliefs and Attitudes toward Science: Is There a Relationship?.," *World J. Educ.*, vol. 9, no. 6, pp. 83–97, 2019.

[25] A. S. Kirmizigul and O. Bektas, "Investigation of pre-service science teachers' epistemological beliefs," *Cypriot J. Educ. Sci.*, vol. 14, no. 1, pp. 146–157, 2019.

[26] M. Lindfors, M. Winberg, and M. Bodin, "The Role of students' scientific epistemic beliefs in computer-simulated problem solving," *Scand. J. Educ. Res.*, vol. 63, no. 1, pp. 124–144, 2019.

[27] J. A. Luft and G. H. Roehrig, "Capturing science teachers' epistemological beliefs: The development of the teacher beliefs interview," *Electron. J. Res. Sci. Math. Educ.*, 2007.

[28] M. T. McCrudden and E. M. McTigue, "Implementing Integration in an Explanatory Sequential Mixed Methods Study of Belief Bias About Climate Change With High School Students," *J. Mix. Methods Res.*, vol. 13, no. 3, pp. 381–400, Jul. 2019, doi: 10.1177/1558689818762576.