

AN EXPLORATION OF SECONDARY SCHOOL SCIENCE TEACHER'S EPISTEMOLOGICAL BELIEF IN MALANG

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ARTICLE INFO	ABSTRACT
Article History: Received 03/01/2024 Revised 03/03/2024 Approved 29/03/2024 Published 30/03/2024	The objective of this study is to delve into the epistemological convictions of secondary school science teachers in Malang across various tenures, namely senior teachers, junior teachers, and pre-service teachers. Employing an explanatory sequential design model, the research employs a mixed-method approach. Quantitative data, gathered through the administration of the Scientific Epistemology Beliefs Questionnaire (n = 30), are complemented by qualitative insights drawn from interviews with teachers (n = 6) concerning their epistemological orientations. Descriptive statistics and qualitative analyses, utilizing an a priori coding technique aligned with the study's conceptual framework, were conducted on the interview data. Quantitative analysis reveals a parity in the level of epistemological beliefs among teachers. However, qualitative examination unveils nuanced distinctions: senior teachers demonstrate transitional epistemological beliefs, while junior teachers and pre-service teachers exhibit traditional and instructive orientations, respectively. These findings hold significance for the enhancement of teachers' professional development in Malang, particularly in the domain of science pedagogy.
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INTRODUCTION

In the realm of education research, extensive inquiry has been dedicated to exploring teacher-related constructs with the aim of optimizing teacher education programs to enhance teacher practice, attitudes, and knowledge (Luft & Roehrig, 2007; Muslimin, 2020; Sappaile, 2017). Central to the objectives of science education is equipping students with the essential competencies to grasp scientific concepts effectively (Sugrah, 2019). In achieving this objective, it is imperative for teachers to grasp how students internalize and shape scientific knowledge. Moreover, a robust correlation has been established between beliefs and their practical manifestations, particularly within educational contexts. Epistemological beliefs, constituting a foundational framework of assumptions regarding knowledge, represent an intricate and self-contained network of beliefs that can be nurtured (Kutluca & Mercan, 2022). It is crucial to note the complexity inherent in understanding beliefs (Sari et al., 2019). In everyday discourse, beliefs are commonly construed as attitudes, dispositions, opinions, philosophies, or values. Epistemological beliefs specifically revolve around an individual's beliefs regarding the nature of knowledge (i.e., its essence) and knowing (i.e., the process of acquiring knowledge), thereby reflecting the teacher's experiences and attitudes (Koutsianou & Emvalotis, 2021). Furthermore, epistemological beliefs can be elucidated as perceptions or conceptions of one's own knowledge and self-awareness (Kim & Im, 2021).

Epistemological beliefs encapsulate a framework of assumptions concerning the fundamental nature of knowledge and the process of learning. Within this framework, delineations emerge at the nexus of acknowledged knowledge, certainty, and criteria for knowledge assessment. These beliefs encompass an individual's comprehension of knowledge acquisition, encompassing its origins, levels of certainty, organizational structure, regulatory mechanisms, and the pace of assimilation (Schommer, 1990). Research conducted by Schommer (1990) suggests a significant association between epistemological beliefs and metacognitive functions such as reading comprehension, active inquiry, and the synthesis of educational materials, thereby implying their potential impact on instructional practices within classrooms (Öztürk, 2022; Sebayang & Silalahi, 2018). Thus, it becomes imperative to explore the interplay between epistemological beliefs and personal or implicit theories of teaching and learning.



Table 1. Subject category of research (Pratiwi et al., 2017).

Subjects	Category
Senior teacher	≥ 10 years
Junior teacher	< 10 years
Pre-service teacher	0 year (have already complete the KPL course)

The conviction surrounding knowledge and learning forms the foundational basis for interlinked decisions aimed at cultivating an effective learning milieu for students (Grecic, 2015; Sudirman et al., 2022). Throughout the educational journey, students harbor attitudes, beliefs, and expectations regarding the subject matter being imparted. For instance, within the domain of science education, the dynamics of interaction between teachers and students wield considerable influence over students' work ethic and conduct (Perkins et al., 2005). Furthermore, teachers' instructional choices and classroom dynamics exert a profound impact on students' attitudes and beliefs towards the learning of scientific concepts (Docktor & Mestre, 2014). Notably, these beliefs serve as a cognitive filter guiding the selection of topics and classroom engagements (Reichert et al., 2021). Consequently, the epistemological convictions held by teachers directly shape their pedagogical practices and, consequently, the learning trajectory of their students (Önal & Kirmizigül, 2021).

Epistemology stands as the cornerstone for teachers in nurturing knowledge, intellect, and self-assurance among their students. Bayraktar (2019) study underscores the pivotal influence of epistemological beliefs on student learning outcomes. A comprehensive examination into the origins of these beliefs holds promise for enhancing student confidence. Shedding light on the epistemological orientations of science teachers according to their tenure could offer further validation for the significance of this domain of inquiry. Kirmizigül and Bektas (2019) conducted research demonstrating that epistemological beliefs exhibit variations across different developmental stages. Consequently, it becomes imperative to factor in these beliefs when devising and implementing developmental initiatives and instructional activities within classrooms. Moreover, students' epistemological beliefs are subject to evolution over time, often influenced by various factors, including pedagogical approaches employed by teachers. The study investigation utilizing both quantitative and qualitative research instruments to delve deeper into factors shaping the development of epistemological beliefs. The researchs aim to explore the epistemological beliefs of secondary school teachers in Malang categorized by their tenure (senior, junior, and pre-service teachers) to enhance the efficacy of science instruction within classrooms, as detailed in Table 1.

METHOD

The methodology of the study is centered on investigating the epistemological beliefs of secondary school science teachers in Malang, specifically in relation to their tenure. This section provides a comprehensive overview of the procedures employed for data collection and analysis, elucidating the rationale behind the chosen methods and techniques. Utilizing a mixed methods approach, the study adopts an exploratory sequential design (Figure 1) to facilitate a thorough examination and understanding of secondary school science teachers' epistemological beliefs concerning their tenure. The selection of a mixed-methods approach is grounded in its efficacy

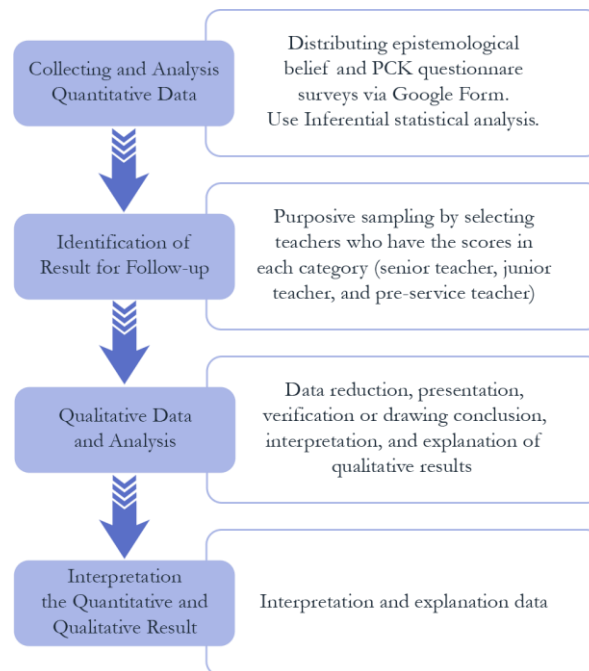
**Figure 1.** Explanatory sequential research design.

Table 2. Questionnaire instrument of epistemological belief.

Aspects	Questions Item
FA (innate or fixed ability)	1–8
LE (process or learning effort)	9–20
EK (authority or expert knowledge)	21–27
CK (certainly knowledge)	28–32

Table 3. Interviews instrument of epistemological belief.

Aspects	Questions Item
Learning	1, 3, 6, 7
Knowledge	2, 4, 5

for systematic data collection and analysis, enabling the description and interpretation of information gathered from various sources including surveys, interviews, and documentation. Following a sequential exploratory design, the approach progresses from quantitative data collection to qualitative data collection, allowing for the elucidation of quantitative findings (Creswell & Clark, 2017).

Quantitative data sampling involved the distribution of surveys via Google Forms to secondary school science teachers in Malang, with 30 participants meeting specific criteria outlined for this study. Purposive sampling was employed for qualitative data selection, a method chosen to ensure the acquisition of nuanced insights into teachers' epistemological beliefs, thus yielding more accurate results. Various factors were considered in the selection of respondents for this qualitative research segment. The sampling process yielded representation from different levels of experience: 2 senior teachers, 2 junior teachers, and 2 pre-service teachers. Subsequently, interviews were conducted to delve deeper into the epistemological perspectives of the teachers. Both questionnaires and interview served as instruments for data collection, as depicted in the Table 2 and Table 3, respectively.

Table 4. The relationship between sub-categories data, dimension of the framework.

View of Science	Category	Pre-service Teacher	Junior Teacher	Senior Teacher
Science as a role or fact	Traditional	I maximize students learning by carefully planning my lessons based on the indicator and goals learning.	I establish the learning objectives to determine whether my students have met them and understood the material.	The material taught adheres to the curriculum provisions. Lesson planning considers what is important to teach students.
	Instructive	I will customize my teaching methods through the use of media that will enhance the material being taught.	After I have given a topic test/chapter review that contains questions related to the initial sub topic to the end of the chapter.	I can assess my students understanding when they are able to draw conclusions and accurately answer question.
Science as consistent connected and object	Transitional	I teach students by conducting experiments, strating with the basics and application in everyday life. This approach helps students understand. the material more effectively.	To enhance the learning experience, I present summarized material in a clear and concise manner and engage students in collaborative learning activities, such as conducting experiments.	I think learning science effectively can be achieved through classroom learning and laboratory use.
Science as a dynamic structure in a social and culture context	Responsive	I recommend conducting project work that includes research to understanding with scientific evidence, rather than relying solely on theory.	Demonstrations and group discussions follow and students are encouraged to recall what they have learned. If any misconceptions arise, I will be clarified or corrected.	I facilitate learning through group discussions, allowing students to actively participate.
	Reform-based	-	-	I evaluate students understanding through competency test. If a student scores below the minimum completeness criteria, remediation will be provided before moving on to a new topic.

The questionnaire instrument is structured to evaluate the extent of science teachers' epistemological beliefs across four dimensions as delineated by [Chan and Elliott \(2004\)](#) model. Employing a 5-point Likert scale, the survey encompasses seven questions probing respondents' epistemological stances, which are then classified into traditional, instructive, transitional, responsive, and reform-based levels. Quantitative data derived from the questionnaire will undergo analysis via descriptive tests, providing insights into the distribution and characteristics of responses. Conversely, qualitative data will be subjected to analysis utilizing the a priori coding technique, which aligns with the framework adopted in this study. [Table 4](#) illustrates exemplary categories derived from the interview data, demonstrating the coding structure utilized for qualitative analysis.

RESULTS

This investigation delves into the epistemological beliefs of secondary school science educators, stratified by their tenure within the profession. Employing quantitative methodologies and purposive sampling, a cohort of 30 teachers in Malang was surveyed. The collected data underwent rigorous descriptive analysis, aiming to delineate the challenges encountered by science instructors in Malang and to elucidate their perspectives on epistemological beliefs. These findings not only address the initial research inquiry but also provide a foundational platform for subsequent investigations. Moreover, the analytical scrutiny furnishes a theoretical framework conducive to elucidating the evolution of teachers' epistemological beliefs through structured interviews.

The study employed two data collection methods: surveys and interviews. The survey questionnaire, adapted from [Chan and Elliott \(2004\)](#) instrument, utilized a Likert scale featuring five levels ranging from "strongly disagree" to "strongly agree", each corresponding to a numerical value from 1 to 5. The survey focused on four distinct aspects: innate or fixed ability (FA), process or learning effort (LE), authoritative or expert knowledge (EK), and certainty of knowledge (CK). FA represents teachers' beliefs regarding their inherent abilities, while LE pertains to the acknowledgment of effort and process in knowledge acquisition. EK reflects the extent to which teachers attribute knowledge to experts and authorities, and CK relates to the belief in the certainty and unchanging nature of knowledge. The survey results are presented in the [Table 5](#).

The study comprised 30 secondary school science teachers, categorized by their tenure: 10 senior teachers, 10 junior teachers, and 10 pre-service teachers. Statistical analyses and descriptive assessments of the teachers' epistemological beliefs, stratified by tenure, were conducted using the SPSS program.

The epistemological beliefs questionnaire results facilitated the categorization of the 30 participants' epistemological belief profiles. To draw conclusions, the average score of each questionnaire item within each aspect was computed, and subsequently, the final outcome was determined by dividing each aspect's average score by its total average. Response quality was assessed across five levels: very poor (0–20%), poor (21–40%), fair (41–60%), good (61–80%), and excellent (81–100%).

[Table 5](#) reveals that senior teachers, with over 10 years of experience, demonstrate remarkable proficiency in the CK (certainly knowledge) domain. This domain signifies a steadfast belief in the definitiveness, clarity, and unchanging nature of knowledge. Similarly, prospective teachers with zero years of experience, provided they meet the requisite criteria, have completed KPL activities, and have not been under higher authority, exhibit commendable performance in the CK domain, indicating a perception of knowledge as definite, evident, and immutable.

Table 5. Quantitative result.

Aspects	Items	Subjects	Min.	Max.	Mean	SD
FA	8	Senior	19	40	25.37	8.10
		Junior	13	28	18.25	4.92
		Pre-service	17	30	23.62	4.75
LE	12	Senior	33	44	40.33	3.84
		Junior	33	46	40.42	4.98
		Pre-service	32	44	38.25	4.16
EK	7	Senior	26	37	31.43	3.91
		Junior	24	40	33.43	5.13
		Pre-service	27	38	33.71	4.53
CK	5	Senior	32	45	41.60	5.64
		Junior	39	44	41.60	2.07
		Pre-service	26	42	37.40	6.54

Table 6. Percentage of teacher's epistemological belief.

Subjects	Percentage (%)	Level
Senior	69.7	Good
Junior	67.1	Good
Pre-service	66.9	Good

Upon scrutiny of [Table 6](#), senior teachers, junior teachers, and pre-service teachers are all classified as “good”, denoting a robust overall epistemological stance. Notably, the percentage value for senior teachers surpasses that of their counterparts. These findings regarding the distribution of epistemological beliefs among secondary school educators corroborate the assertion made by [Sari et al. \(2019\)](#) that individuals with longer tenures tend to exhibit higher levels of epistemological belief compared to their less experienced counterparts.

Additionally, the study employs the a priori coding technique, which leverages a pre-established framework to elucidate the outcomes of epistemological interviews concerning teachers’ beliefs. This form of interview facilitates a more in-depth comprehension of the results gleaned from prior questionnaire administrations, thereby bolstering the validity of the findings. The coding segmentation is delineated in [Figure 2](#), depicting the responses of secondary school teachers categorized based on their tenure. [Figure 2](#) summarizes the outcomes of a qualitative analysis conducted on the epistemological beliefs of secondary school science teachers. This analysis was based on coding that encompassed teacher-focused (traditional and instructive), transitional (transitional), and student-focused (responsive and reform-based) approaches.

As illustrated in [Figure 2](#), pre-service teachers who possess experience and have completed the KPL course typically exhibit an instructive epistemological belief character. This implies a tendency towards emphasizing experiences and making teacher-centered decisions in science teaching. For instance, one pre-service teacher expressed intent to provide practical experiences to students, stating: “If needed, I will teach practicum, whether it is virtual or real”. Such practicum-based learning endeavors align with the requirements of scientific inquiry, facilitating students’ attainment of learning objectives ([Subiantoro, 2010](#)).

Moreover, teachers with less than 10 years of experience often demonstrate a traditional epistemological approach, prioritizing the dissemination of information and adherence to established structures in science education. For example, a junior teacher described a teaching scenario where the teacher presents material while the student observes and takes comprehensive notes. Despite the historical prevalence of teacher-centered approaches in science education, contemporary pedagogy underscores the importance of student involvement in constructing knowledge. Hence, junior teachers are encouraged to enhance their skills and promote student-centered learning ([Maulani et al., 2021](#)).

In contrast, most senior teachers with over 10 years of teaching experience manifest a transitional epistemological belief character. They concentrate on teacher-student relationships, subject-matter choices, or affective responses in science teaching. Senior teachers are tasked with guiding students in developing understanding and process skills. They often lead group discussions to foster active student participation, recognizing discussions as pivotal for integrating initial knowledge through peer interaction ([Fayakun & Joko, 2015](#)).

However, unlike their counterparts, senior teachers also exhibit a reform-based epistemological belief character, indicating an improvement in teaching methods and increased attentiveness to student needs. This belief suggests that teachers aim to provide students with scientific experiences that enhance their comprehension and ownership of knowledge. This aligns with research suggesting that a teacher’s epistemological beliefs significantly influence student learning outcomes and confidence ([Bayraktar, 2019](#)). Therefore, a teacher’s higher epistemological character correlates with enhanced learning quality.

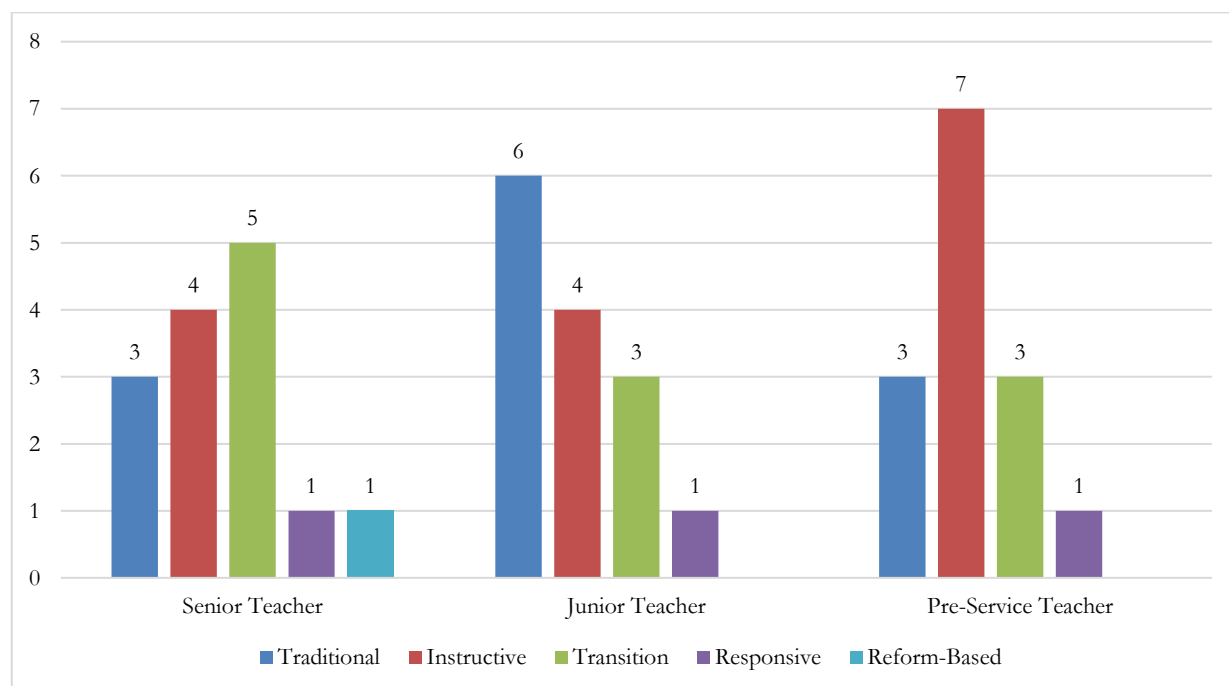


Figure 2. Comparison of result qualitative analysis epistemological belief secondary school sciences teachers.

DISCUSSION

Epistemological beliefs, encompassing an individual's perspectives on the acquisition of knowledge, encompass a spectrum of beliefs regarding its nature, accuracy, sources, and organizational structure (Öztürk, 2022; Çarkıt & Kurnaz, 2022). These beliefs wield considerable influence over educators' instructional approaches, thereby underscoring the imperative for educators to continually refine their epistemological frameworks (Kirmizi & Irgatoğlu, 2021). The tabulated data in Table 5 delineates the mean epistemological beliefs among seasoned educators across distinct categories, as adapted from Chan & Elliott (2004), covering facets such as authority or expert knowledge (EK), certainty of knowledge (CK), engagement in learning processes (LE), and beliefs regarding innate or fixed abilities (FA), derived from meticulous quantitative data analysis.

Analysis of Table 5 reveals that senior teachers, junior teachers, and pre-service teachers all exhibit elevated levels of epistemological beliefs. Notably, senior and junior educators demonstrate remarkable proficiency in the realm of CK, signifying a staunch conviction in the stability, clarity, and immutability of knowledge. Conversely, prospective teachers showcase notable prowess in the LE dimension, underscoring their belief in the direct correlation between exerted learning effort and resultant learning outcomes. This observation aligns with Chai (2010) findings, which highlight pre-service educators' robust conviction that heightened dedication to the learning process yields commensurate enhancements in learning outcomes.

Furthermore, across all three teacher categories, the FA dimension, which concerns beliefs in innate abilities, registered the lowest scores. Specifically, senior teachers averaged a score of 25.37 (SD 8.10), junior teachers 18.25 (SD 4.92), and prospective teachers 23.62 (SD 4.75). These findings suggest a pervasive uncertainty among educators and teacher candidates regarding the innateness or fixity of abilities. Contrary to the notion of innate abilities, Kirmizi and Irgatoğlu (2021) assert that teachers' capacities are not predetermined at birth nor confined to inherent traits. They refute the concept of individuals being inherently adept learners. The study underscores the steadfast conviction of both senior and junior educators in the CK dimension, emphasizing the steadfastness and immutability of knowledge. Conversely, prospective teachers exhibit a robust belief in the LE dimension, emphasizing the paramountcy of effort in the learning process. Notably, Chan and Elliott (2004) contend that learning effort plays a pivotal role in knowledge acquisition. Moreover, their research indicates teachers' acknowledgment of the evolving nature of scientific understanding. Discrepancies in findings could be attributed to past pedagogical experiences characterized by direct transmission of knowledge from teachers to students. However, a comprehensive exploration is warranted to unravel the intricate nuances of teachers' epistemological convictions (Sebayang & Silalahi, 2018).

In complement to the quantitative examination, this study conducted a qualitative inquiry employing interviews. The interview protocol, derived from Luft and Roehrig (2007), encompassed seven inquiries concerning learning and knowledge. Subsequently, the findings were categorized into five distinct levels: traditional, instructive, transitional, responsive, and reform-based, offering a multifaceted understanding of participants' perspectives on pedagogy and epistemology.

The concept of "learning" in this study was not explicitly delineated by the researchers, likely due to the ongoing debate surrounding its precise definition. However, drawing from the work of Nacaroglu and Kızıkan (2021), learning is understood as the process by which individual behavior undergoes modification. This facet encompasses four inquiries pertaining to classroom management, assessment practices, self-regulation, and instructional planning.

The initial query focused on classroom management strategies aimed at optimizing learning environments. Analysis unveiled that both senior and junior educators predominantly harbor transitional epistemological beliefs in this domain, albeit some junior instructors still retain traditional perspectives. Moreover, pre-service teachers tend to exhibit instructive epistemological orientations. Echoing the findings of Jumrawarsi and Suhaili (2020), senior educators are inclined towards employing activities that foster student autonomy and cultivate a positive classroom ambiance, essential for effective pedagogy. Conversely, junior teachers prioritize cultivating a supportive classroom milieu conducive to enriched teaching and learning experiences, often through experimental methodologies. Mularsih and Hartini (2019) advocates that a nurturing classroom environment significantly enhances student learning outcomes.

Despite efforts by some junior teachers to augment classroom learning through structured lesson planning, instructional materials utilization, and well-organized class activities, their epistemological beliefs often align with traditional paradigms. Additionally, prospective teachers who emphasize meticulous planning and leverage educational media tend to positively influence student outcomes. In the contemporary educational landscape, the integration of digitally-mediated learning tools leveraging advanced technologies has emerged as a prevalent pedagogical strategy (Peña-Ayala, 2021). Crucially, such modalities should foster critical and creative thinking (Suryandari et al., 2021) and cultivate higher-order cognitive skills among students (Rahmawati & Atmojo, 2021).

The second inquiry delves into how teachers assess students' comprehension of the material. Analysis reveals that across senior, junior, and prospective educators, there is a prevailing inclination towards instructive epistemological beliefs. However, it is noteworthy that some senior and junior teachers still maintain traditional epistemological orientations. Within the cohort exhibiting instructive epistemological beliefs, three discernible categories emerge. These teachers gauge student understanding by assessing their ability to reproduce or demonstrate acquired knowledge, such as drawing conclusions and posing inquiries using a question-and-answer approach. Such pedagogical practices engender an environment where students feel empowered to voice their perspectives and respect those of their peers (Safira et al., 2021). Conversely, a traditional epistemological stance is evident when teachers primarily focus on disseminating information to students and monitor their problem-solving processes without actively engaging in dialogue or employing the question-and-answer method. Utilization of the question-and-answer method fosters an interactive learning atmosphere and shifts the onus of learning from the teacher to the students (Priyanto & De Kock, 2021).

The third inquiry probes into a teacher's self-management in effectively teaching science. Analysis indicates that senior, junior, and prospective teachers alike demonstrate transitional epistemological beliefs in this domain. These beliefs suggest that optimal science instruction involves adhering to procedural frameworks or guidelines for conducting experiments in laboratory settings, or engaging students in activities such as observational studies. Engaging in laboratory work offers students insights into the operational methodologies of scientists, potentially shaping their attitudes towards scientific endeavors (Sulistiyono et al., 2019). However, some senior educators still espouse instructive epistemological beliefs, expressing reservations about the practicality of laboratory activities due to constraints such as time limitations and a restricted number of available activities. In such instances, these senior teachers tend to model activities for students to emulate. Conversely, junior and prospective teachers harbor epistemological convictions emphasizing that students attain a deeper understanding of science through direct engagement with and interpretation of natural phenomena. The utilization of discussion methodologies challenges students to construct their own comprehension of data and articulate their viewpoints. Supriyati (2020) asserts that group discussions serve as an efficacious avenue for achieving these objectives, fostering critical thinking skills and bolstering self-assurance among students.

The fourth inquiry delves into the teacher's planning process to discern when learning transpires within the classroom setting. Analysis reveals that senior teachers predominantly exhibit a responsive epistemological orientation by fostering discussions among students regarding the topic under consideration. However, their responses remain somewhat constrained or are primarily provided at the onset of the discussion. Typically, these teachers initiate problem-solving tasks, subsequently organizing students into groups to collaboratively dissect and resolve them. Such pedagogical practices cultivate critical thinking skills and encourage democratic problem-solving dynamics among students (Supriyati, 2020).

Nevertheless, a subset of senior educators still adheres to transitional epistemological beliefs, contending that learning extends beyond the classroom confines and necessitates students' active engagement and subsequent reflection. The utilization of discussion methodologies is deemed efficacious in promoting active learning and nurturing an ethos of respect for diverse viewpoints among students.

Conversely, junior and prospective teachers often espouse epistemological beliefs that underscore the pivotal role of the teacher in gauging learning outcomes within the classroom milieu. They accentuate the significance of arriving at correct answers by advocating for student engagement in experimental inquiries, result analysis, and assessments. However, a contingent of prospective teachers retains traditional epistemological convictions, positing that learning is contingent upon students' activities during the learning process. They prioritize students' attentiveness and tranquility, advocating for a serene learning environment throughout instructional sessions.

The second aspect under scrutiny is knowledge, encompassing inquiries into the essence and manifestation of human understanding, as well as the methodologies employed in its validation, justification, or consolidation. This dimension comprises three inquiries pertaining to the notions of responsibility, decision-making, and evaluation.

The initial query delves into the educator's responsibility in delineating their role within the educational landscape. Analysis reveals that senior teachers, junior teachers, and prospective educators predominantly espouse transitional epistemological beliefs in this regard. They posit that educators are tasked with exemplifying role models for their students and surroundings. Consequently, a teacher's efficacy as a role model is contingent upon possessing commendable personal attributes, such as responsibility, authority, independence, and discipline (Munawir et al., 2022).

However, a subset of senior teachers already exhibits epistemological beliefs aligning with a reform-based paradigm. These educators perceive themselves as catalysts for student motivation. Beyond imparting knowledge, they perceive their role as inspiring students to develop a fervent enthusiasm for learning physics. The provision of motivation by teachers stands as a pivotal component of the educational journey, nurturing students' confidence to persist in their pursuits and endeavors. Sabaniah et al. (2021) posit that cultivating teachers who serve as motivators is indispensable for instilling confidence in students to articulate their viewpoints.

Conversely, some pre-service teachers retain traditional epistemological convictions. These educators perceive their role as solely dispensing information and structuring learning experiences, neglecting the importance of fostering collaborative dynamics between educators and students.

The second question, focusing on decision-making in terms of what content to include or exclude in teaching, reveals that senior teachers, junior teachers, and prospective educators largely maintain traditional levels of epistemological beliefs. Their decision-making processes revolve around adhering to curriculum guidelines or school-specific factors, with a focus on prioritizing essential subject matter.

In the evaluation of when to transition to a new topic, findings indicate that senior teachers, junior teachers, and prospective educators predominantly exhibit instructive epistemological beliefs. They assert that the timing of transitioning to a new topic in the classroom hinges upon the mutual consideration of the teacher's guidance and the students' grasp of fundamental facts and concepts. This determination is often informed by competency assessments. Nonetheless, a segment of junior teachers retains traditional epistemological beliefs, insisting on awaiting explicit directives from the teacher before transitioning to a new topic, irrespective of achieving the learning objectives.

The findings presented imply that teachers' epistemological beliefs are malleable within certain contextual boundaries. For instance, pre-service teachers inclined towards student-centered pedagogies can undergo a transformation towards a more responsive ideology with targeted assistance. Conversely, novice educators may gravitate towards traditional or simplistic instructional methods in the absence of sufficient support structures. It's noteworthy that beliefs are not static entities; they have the propensity to evolve over time (Martin et al., 2019).

Moreover, external factors, particularly those associated with teachers' professional development, exert significant influence over their epistemological orientations (Fang, 1996). These external influences play a pivotal role in shaping and reshaping teachers' perspectives on knowledge acquisition, instructional strategies, and student learning outcomes.

CONCLUSION

This investigation seeks to explore the epistemological beliefs among secondary school science teachers, stratified by their levels of experience. The study encompasses participants from distinct tenure categories: senior teachers, junior teachers, and pre-service teachers. Through a structured inquiry, the findings reveal a convergence in epistemological beliefs across these groups, particularly emphasizing a predisposition towards certain knowledge (CK)—a conviction in knowledge that is definitive, unequivocal, and immutable. However, a notable area for improvement lies in their belief regarding innate or fixed self-abilities (FA), which warrants further reinforcement. Moreover, it is observed that while some pre-service teachers exhibit an instructional level of epistemological beliefs, junior teachers tend to adhere to more traditional beliefs. Conversely, senior teachers, benefiting from specialized training, manifest a shift towards reform-based epistemological perspectives, thereby fostering a more constructive outlook among all educators. It is paramount to underscore the pivotal role of teacher confidence in shaping student learning trajectories. Despite the valuable insights garnered, certain limitations must be acknowledged. The current study's scope necessitates a larger sample size to offer a more representative depiction of secondary school teachers in Malang. Furthermore, in adherence to ethical protocols, the researchers have upheld strict confidentiality measures to safeguard the anonymity of the respondents.

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AUTHOR CONTRIBUTIONS

AN contributed to the conceptualization of the study, methodological design, conduct of the investigation, and preparation of the initial manuscript. EP and NM involvement included conceptualization, methodological design, formal analysis, data curation, and manuscript editing. AD contributed to data curation and analysis within the realm of epistemic education. All authors participated in review and editing of the manuscript.

CONFLICT OF INTEREST STATEMENT

With respect to the investigation, composition, and dissemination of this manuscript, the authors affirm that they do not possess any conflicting interests.

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