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The importance of questioning in the context of climate change education

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ABSTRACT

Questioning plays a critical role in deepening students' understanding and increasing their engagement in the context of science education, especially when addressing complex global issues such as climate change. This study aims to examine the role of questioning in the context of climate change education through a comprehensive literature review. A comprehensive database search was conducted in line with the identified keywords, and a total of 20 articles published between 2004 and 2024 were selected. The selected articles were analyzed in two categories, which are inquiry in education and inquiry in climate change education. The research findings reveal that questions are addressed differently by teachers and students in education, and that questioning methods make significant contributions to students' learning processes and teachers' pedagogical practices. The findings also indicate that while the importance of inquiry is widely recognized, there is a significant gap in the existing literature on the application of effective inquiry strategies in climate change education. Most studies emphasized the important role of teacher guidance and student curiosity. However, an important limitation of these studies is the lack of concrete pedagogical frameworks that can effectively promote higher-order inquiry. This study highlights the need for more targeted research and educational practices that support inquiry-based learning in the context of climate change. Implications for educators and policymakers are discussed in light of the identified gaps and potential strategies for enhancing inquiry in science education.

Keywords: student's questions, teacher's questions, climate change education, questioning in climate change education, inquiry, comprehensive literature review

INTRODUCTION

Humans are born with a natural sense of curiosity and a desire to explore their immediate surroundings and ultimately the entire universe (Spektor-Levy et al., 2013). Curiosity is a marvel of the human mind (Lindholm, 2018). People look for wonder in everything, even the most ordinary things. Every object, every movement, and every phenomenon around them attracts their attention because they are surrounded by countless things that naturally interest them. They carefully observe all these things and wonder why these things happen. At the same time, they discover problems in their daily lives during their observations, and they want to solve these problems. The "why" and "how" questions they constantly ask stem from their need to know (Agee, 2009).

People who encounter many problems in their daily lives, first question the reasons for these problems. Science has emerged from the need of people to find answers to these questions. The main purpose of science, which centers on these problems encountered in daily life, is to ask questions about the natural world and then seek answers (Özkan & Çetin, 2021). Identifying what encourages curiosity for this answer should be of major importance for science education and society (Lindholm, 2018) because science tries to understand and explain the world (Cil & Cepni, 2012). In general, science is the essence of knowledge and skills that have the idea of understanding and interpreting the earth and environment in which people live, and seeking regularity in this environment (Hançer et al., 2003). In order to reach the right answers in scientific research, first of all, the right questions must be asked. At this point, it is an important issue how the questions should be, which can be described as the main reason for the emergence of research.

In scientific research, questions should express what the researcher wants to explore about the goals and perspectives of people involved in social interactions. Good questions are typically generated or refined in the process of a reflective and participatory inquiry journey. These questions may change during the research process to reflect a better understanding of the problem (Creswell et al., 2007). The questions continue to change, influenced by the perspectives of researchers in the inquiry process and the new dimensions that research gains.

To explain this with a metaphor, it is useful to think of research questions as a guide that can help a researcher map out possible paths and at the same time question the unexpected (Agee, 2009). Student and teacher questions represent a fundamental element of scientific pedagogy, exerting a pivotal influence on the learning process (Tolppanen & Aksela, 2018). Student questions are regarded as a valuable resource for fostering a meaningful learning environment and for implementing effective inquiry-based teaching (Sezen-Barrie et al., 2019). Such inquiries not only facilitate the advancement of existing conceptual frameworks but also contribute to the construction of knowledge by directing the learning process. It has been posited that students derive enjoyment from conducting inquiry based on their own questions, thereby creating a valuable resource for scientific learning (Sihvonen et al., 2023). Similarly, the questions teachers pose and the manner in which they approach these questions directly influence the quality of classroom discourse. Teacher questions are typically employed to direct students' attention toward the subject matter, evaluate their existing knowledge, and guide them toward new learning objectives (Chin, 2007). By employing essential questions to establish a dialogue-oriented learning environment, educators can facilitate students' cognitive thinking abilities and encourage their active participation in discussions (Zhang & Chen, 2024). This pedagogical approach transcends an authoritarian style and creates a more conducive atmosphere for student voice and creativity. However, in the literature, there has been moderate research in the field of education on the use of student questions as a tool to enhance learning experiences (Tolppanen & Aksela, 2018). Climate change education aims to develop students' understanding of complex environmental problems and their ability to generate solutions. Due to its multidimensional nature, students' ability to ask active questions is critical in this process (Gautier & Solomon, 2005). Asking questions is necessary in order to think deeply about the issues, to make sense of them and to play a role in the processes of generating solutions. Student questions asked at different levels are related to their ability to ask questions and their ability to understand and apply scientific concepts (Shepardson & Pizzini, 1991). Therefore, this comprehensive literature review aims to present the current literature about questioning in climate change education. The research is guided by the following research question:

RQ1 How does research reflect on the importance of questioning in the context of climate change?

LITERATURE REVIEW

Curiosity

Curiosity is the emotion that drives living things to learn and discover new things. Curiosity is defined as the desire to comprehend diverse occurrences and the pursuit of knowledge (Pisula, 2009). Although curiosity is described as a desire to know, it may not be true to limit its definition to only the desire to know. That is, to wonder is more than simply a wish to know; to be inquisitive, there must be something more than just a desire to know. Inan (2014) defines curiosity as "inostensible concepts". He describes it as what the intellect does not understand or cannot comprehend. Curiosity serves as an innate desire to learn, investigate, and examine the world and the unknown (Silvia, 2008). Curiosity may be stimulated or prompted by external or situational stimuli and can transform into a persistent desire to engage in context-specific interests throughout the interest-building process (Krapp & Prenzel, 2011). According to Dewey (1910), curiosity is the most important component of learning. The beauty of curiosity is that it creates a self-sustaining learning cycle. Curiosity is essential for human cognitive, social, emotional, spiritual, and physical development, education, and scientific exploration because it allows people to gather various knowledge, skills and experiences (Silvia, 2008). As curiosity pushes individuals to study and acquire new information, it allows them to realize more subtle distinctions, as well as more conflicting and sophisticated viewpoints on that knowledge (Spektor-Levy et al., 2013). Scientific curiosity is defined as the urge to understand and learn about natural processes (Krapp & Prenzel, 2011). Thus, curiosity can drive individuals to act in a specific manner, take certain actions, and practice certain abilities that will allow the reveal of new knowledge. In scientifically curious people, the results of these actions can have effects such as conducting research that enriches their scientific knowledge, reviewing the literature and implementing inquiry skills in the process. Furthermore, the core purpose of science education, which is the flourishing of intrinsic curiosity, is highly influenced by instructors' understanding of, preservation of, and nurturing of a people's scientific interest. In more detail, well-known scientists have expressed the importance of curiosity as well as wonder or indeed "amazement" in scientific inquiry (e.g. Einstein, 1931; Sagan, 1995). Although the connection between curiosity and science has been the subject of research, it has rarely been studied in climate change education (Sezen-Barrie et al., 2019). It is noteworthy that children who begin to encounter the effects of climate change in their daily lives associate this education with negative emotions (Oberman, 2024). Although children did not cause climate change, they should be exposed to educational opportunities to learn why and how climate change occurs so that they can learn to cope with its consequences (Schenkel et al., 2024).

Questioning in Education

Questioning is a basic tool that individuals use in learning processes to access information, question existing concepts and create new meanings. Questioning in education aims not only to transfer knowledge but also to develop learners' critical thinking and problem-solving skills. Asking questions provides cognitive depth in learning processes and develops students' scientific thinking skills (Zhang & Chen, 2024). In education, questioning is used as a tool for students to question and reflect on their existing knowledge. This process allows teachers to guide students' thought processes and make learning more meaningful. Students' questions help them to better understand scientific concepts, make new connections and deepen the learning process (Sihvonen et al., 2023). Students' questions support not only individual learning but also the processes of developing new perspectives and creative solutions within the group. In this context, asking questions, as an active component of learning, increases students'

engagement in meaningful learning and scientific inquiry processes (Tolppanen & Aksela, 2018). While students' forming their own questions helps them to direct the learning process, it also forms the basis of scientific inquiry. In particular, "curiosity questions" or "wonder questions" are seen as a valuable resource for students to question their current level of knowledge and make connections with new concepts (Sezen-Barrie et al., 2019). Questions that are initially aimed at basic knowledge become more analytical and critical as the process progresses. This evolution contributes to the development of students' scientific thinking skills and makes learning more meaningful (Lombardi et al., 2016). While low-level questions focus more on recalling information, high-level questions focus on developing students' analysis, synthesis and evaluation skills. Such high-level questions allow for richer and more comprehensive discussions to take place in the classroom (Eshach et al., 2014).

Likewise, teachers' questions have a critical role in developing students' conceptual skills and enriching classroom discussions. Questioning in education not only conveys knowledge but is also a learning mechanism that encourages learning, exploration, and inquiry (Shanmugavelu et al., 2020). Both teachers' and students' questions are considered as a mechanism that shapes the learning environment, creates meaning beyond information retrieval, and encourages critical thinking. Teacher questions serve as a guide for students to evaluate their existing knowledge and make sense of new information (Zhang & Chen, 2024). Open-ended questions and approaches that encourage thinking enable students to make conceptual connections and think from different perspectives (Kabataş Memiş, 2011). Students' active role in this process makes learning more meaningful and enriches the process of accessing information. Thanks to the ability to ask questions, individuals who succeed in reaching the right information grow up (Akkaya, 2024).

As a result, both teachers' and students' questions are a tool to promote critical and creative thinking in education beyond acquiring knowledge (Eshach et al., 2014). Questions in education are powerful mechanisms that expand the boundaries of learning, create meaning and transform learning (Lombardi et al., 2016).

Climate Change Education

Climate change education is a critical process that facilitates individuals' comprehension of environmental issues, cultivation of scientific thinking skills, and engagement in actions to address these issues (Monroe et al., 2019). Education's objective is not solely the acquisition of scientific knowledge, but also the generation of meaningful solutions at personal and societal levels. Climate change education is not merely a transfer of scientific knowledge; rather, it is an interdisciplinary approach that aims to equip individuals with the tools necessary to navigate the challenges they may encounter in a complex and uncertain future (Stevenson et al., 2017). In this context, education should be regarded not only as a tool that increases individuals' knowledge but also as a mechanism that strengthens their capacity to adapt to climate change (Prentice et al., 2024). To that end, climate change education should adopt an interdisciplinary approach that enables individuals to respond to this complex problem with its scientific, social, ethical, and political dimensions (Rousell & Cutter-Mackenzie-Knowles, 2020). In this context, effective climate change education strategies are based on presenting personal meaningful and relevant information and encouraging students to actively participate. For instance, projects that link local examples to global impacts can enhance students' understanding of the topic and motivate them to take environmental action (Monroe et al., 2019). Furthermore, interactive methods such as guided discussions and scientific data analysis are often used to address students' misconceptions and encourage critical thinking (Stevenson et al., 2019). These approaches support students to understand complex environmental issues and develop solutions based on this knowledge. Consequently, climate change education integrates scientific knowledge with a sense of social responsibility, thereby fostering a learning process that strengthens individuals' environmental awareness and action (Monroe et al., 2019).

Questioning in Climate Change Education

Climate change education aims to enable students not only to acquire knowledge, but also to critically analyze environmental problems, develop solutions to these problems and take meaningful action at the individual or societal level. In this process, questioning, as one of the cornerstones of scientific inquiry, is a powerful pedagogical tool that supports students' active participation in the learning process. Questions generated by students allow them to question their existing understandings, make connections to new knowledge and develop deeper understanding. Student-generated questions create meaningful learning environments in the context of science education and provide opportunities to make sense of complex issues, especially climate change (Tolppanen & Aksela, 2018). Such questions not only increase students' environmental awareness but also allow them to develop solution-oriented thinking skills (Sezen-Barrie et al., 2019). Current literature shows that students have knowledge about climate change and are concerned about it. However, since it is determined that they have little knowledge about understanding the effects of this crisis and implementing it in a sustainable way, the importance of asking questions is emphasized (Rivas et al., 2024).

Teachers' questions provide a critical framework for students to gain a deeper understanding of scientific concepts and address complex problems. Especially open-ended questions that require high-level cognitive skills enrich classroom discussions and increase students' problem-solving capacities (Chin, 2007). Teachers' guiding questions allow students to develop different perspectives (Sihvonen et al., 2023). This type of learning environment offers a learning model that personalizes students' knowledge acquisition processes and strengthens their active participation and awareness of social responsibility.

However, although the importance of asking questions in the context of climate change education is frequently mentioned in literature, there is very limited literature on how effective questions should be. This constitutes a gap for pedagogical approaches in the field (Stevenson et al., 2017; Zhang & Chen, 2024). To bridge the gap between knowledge and action, modern educational concepts should encourage

students to ask questions about climate change by pointing to concrete, climate-friendly forms of behavior and support students' positive attitudes towards climate protection (Feldbacher et al., 2024; Molthan-Hill et al., 2024; Pountney, 2025).

METHODOLOGY

Research Design

Literature review is a way of studying published knowledge in a particular subject area. Literature reviews can cover well-established topics. In these cases, literature reviews often examine existing knowledge to find gaps, change how theories are understood, or critique the methods used. Alternatively, reviews may focus on newer or emerging topics. In these cases, the objective is to combine existing literature into a general conceptual framework or model. The authors outline the basic steps for conducting such a review: “choosing a topic and audience”, “conducting comprehensive search”, “taking notes and organizing ideas”, “deciding on the type of review”, “maintaining focus”, “critical analysis”, “organizing the review logically”, “incorporating feedback”, “balancing objectivity”, “staying current”, “concluding with key findings and future directions” (Karunarathna et al., 2024). This study was guided to include similar steps. It has been observed that there are gaps in literature in this field and that there are not enough studies.

Data Source

The study's data source comprises 20 journal articles from the years 2004 to 2024. The selection of studies was conducted through a comprehensive scanning of major databases, including Google Scholar, ERIC, ProQuest, Taylor & Francis Online, Wiley Online Library, Dergipark, and TRDizin. The following keywords were utilized during the scanning process: "questioning," "student's questions," "teacher's questions," "climate change education," "questioning in climate change education," and "inquiry." The inclusion criteria for this study were the presence of the keywords in the database and the accessibility of the journal articles in question.

Data Analysis

The journal articles included in this study were collected between December 2024 and January 2025. The journal articles were searched using different combinations of keywords, including "questioning," "student's questions," "teacher's questions," "climate change education," "questioning in climate change education," and "inquiry." A literature matrix was created by using Excel. The journal articles were assigned numerical identifiers, and the objectives of the studies were documented in the literature matrix under the derived objectives which were "questioning in education" and "questioning in climate change education". The findings of the studies were then presented.

Table 1. Main ideas of the articles about questioning in education

Articles	Main ideas of Article
Tolppanen and Aksela (2018)	Students’ questions
Zhang et al. (2024)	Teachers’ questioning and gestures
Shanmugavelu et al. (2020)	Teachers’ questions
Yang (2006)	The role of teachers’ questions
Chin (2007)	Teachers’ questions
Zhang and Chen (2024)	Questioning as teaching method
Eshach et al. (2014)	Teachers’ questions
Sezen-Barrie et al. (2019)	Students’ questions
Vale (2013)	The importance of questions for students
Gautier and Solomon (2005)	Importance of questioning in CCE

FINDINGS

A comprehensive literature review was conducted to examine recent research on the use of questioning in climate change education. The main ideas were categorized under "questioning in education" and "questioning in climate change education." The findings of the studies related to each main idea were synthesized and presented.

Questioning in Education

In the literature, it was observed that the concept of questioning was divided into teacher questions and student questions. The reviewed articles were also examined in these dimensions. The reviewed studies and their main ideas are summarized in **Table 1**.

One of the most comprehensive studies on this subject is the work of Tolppanen and Aksela (2018). Tolppanen and Aksela's study examines how students' questions about climate change can be used as a meaningful tool in the educational process. In the study, a total of 355 open-ended questions from students were analyzed and these questions were classified under five main categories:

1. Climate System Framework,
2. Impacts on Humans,
3. Solutions to Climate Change,
4. Awareness Raising and
5. Human Action.

This categorization reflects students' efforts to understand different dimensions of a complex issue such as climate change. The study shows that students do not only stay at the level of acquiring knowledge but also try to understand complex systems with a solution-oriented approach. The intensity of the questions students asked about solutions to climate change reveals that they are actively seeking solutions to this issue. In addition, the questions posed by students in the context of ethical and social responsibilities play an important role in the process of raising environmental awareness. In this article, it is emphasized how these questions can be guided under teacher guidance and a “guided inquiry” approach is proposed to develop students' inquiry skills. This

approach allows students to deepen their scientific inquiry processes, better understand complex problems and generate solutions. The study also emphasized that teachers' responses to students' questions and their guidance role in this process are critical to make the learning process more meaningful. In this context, Tolppanen and Aksela's (2018) study shows that student questions are not only a tool that enriches the learning process, but also a powerful method that can be used in education to understand and solve global issues such as climate change.

In their research, Zhang et al. (2024) emphasize the importance of posing inquiries to cultivate a classroom discourse environment. Teacher questions function not only as a tool to encourage student engagement but also as a tool to promote the development of students' cognitive skills and learning (Biggers, 2018; Orr & Bieda, 2023). According to the taxonomy developed by Bloom et al. (1956), teacher questions can be utilized to prompt students to retrieve information (low cognitive level), to evaluate students' comprehension (high cognitive level), or to direct students towards abstract and self-reflective thinking (high cognitive level). In this context, higher cognitive level questions support students' understanding of complex concepts and the generation of creative solutions regarding these concepts. Furthermore, as in Tolppanen and Aksela's (2018) article, teachers' gestures, as an element that reinforces these questions, facilitate students' comprehension of the questions' intended meaning. The incorporation of abstract gestures and probing inquiries, such as "why" and "how," has been identified as a pivotal factor in fostering students' critical thinking abilities.

Shanmugavelu et al. (2020) examined in detail the questioning techniques used by teachers in classroom teaching and learning processes. The study reveals that effective questioning methods play an important role in capturing students' attention, developing their thinking skills and increasing their motivation to learn. Questioning is a powerful teaching tool used not only to gauge students' existing knowledge but also to encourage critical thinking, creativity and problem-solving skills. The article analyzes the questioning techniques used by teachers in relation to factors such as tone and clarity, waiting time, content and distribution of questions. In addition, based on Bloom's cognitive domain taxonomy, it is stated that diversifying questions at the levels of knowledge, comprehension, application, analysis, synthesis and evaluation deepens students' thinking processes. It was emphasized that open-ended questions that encourage different thinking perspectives are important in developing students' independent thinking skills. The results suggest that teachers' deliberate planning of questioning techniques and providing equal opportunities for each student to participate create a more active and meaningful learning environment in the classroom.

Yang (2006) posits that education should foster the development of profound and meaningful inquiries among learners, as opposed to merely providing direct answers. In the learning process, knowledge should be regarded as a content that necessitates questioning with the active participation of learners rather than passively transmitted. A process-oriented understanding of educational content, as opposed to a more traditional content-based approach, should be adopted. Yang (2006) further asserts that the dynamic interaction between educators and students constitutes a recurrent cycle, which is outlined as follows: This cycle, as delineated by Dillon (1990) and Westgate and Hughes (1997), involves a sequence of interactions between teacher and students, culminating in a cycle of "teacher's question – students' responses – feedback." The role of the teacher's questions in this dynamic is pivotal, serving as a critical catalyst that fosters students' deeper engagement in the learning process and generates meaningful learning environments. According to Yang (2006), students' inquiries play a pivotal role in the teaching and learning processes, offering opportunities for pedagogical interventions. In this context, education needs to be reshaped as a participatory inquiry environment, focusing on processes rather than outcomes.

Another research like Yang (2006) that is to examine the teacher-student relationship in terms of questioning. According to Chin (2007), the process of students constructing meanings and developing understandings in a social context while learning science is dependent on teacher-student interaction. The utilization of effective questioning techniques in the classroom is identified as a significant tool to support students' deeper understanding of scientific concepts and the development of critical thinking skills. The teacher's role is to assist students in comprehending and internalizing ideas, as well as to provide support in applying these ideas. Chin (2007) further elaborates on various questioning approaches in his article. The methods employed in this study include Socratic questioning, verbal jigsaw, semantic tapestry, and framing. These approaches are designed to encourage students to generate and question new ideas based on their existing knowledge through teacher questions, drawing on students' everyday views, developing holistic thinking by connecting different ideas, or guiding them to understand the scope of the problem.

There are other articles that mention teaching methods. Zhang and Chen's (2024) study systematically examined the impact of teaching methods on students' learning processes. The study highlighted the efficacy of open-ended questions in fostering critical thinking and creative problem-solving skills in students. Specifically, it was noted that scenario-based questions enabled students to adopt the perspective of scientists, thereby enhancing their scientific inquiry abilities. The analysis revealed that questions employed during group activities promoted critical thinking and augmented student interaction. Furthermore, it was observed that questions posed at the individual level enhanced students' ability to articulate and substantiate their own ideas. The study underscores the pivotal role of teachers' questioning strategies in fostering students' active engagement in learning and cultivating meaningful learning environments.

When teacher-student questions and responses are compared, the results are noteworthy. According to Eshach et al. (2014), questioning is a fundamental pedagogical tool employed by teachers to diagnose and extend students' thinking processes and facilitate the development of conceptual knowledge. The utilization of questioning has also been demonstrated to foster students' thinking processes, stimulate their curiosity, and fortify their classroom interactions. The study's findings indicate that teacher

questions fulfill five primary functions: they stimulate students' interest and curiosity, facilitate interaction, develop students' thinking skills, maintain their alertness, and assess their level of knowledge. The research findings indicate that in science lessons, teachers pose twice as many questions as students, with students' inquiries accounting for approximately one-third of the total questions. This proportion has increased in response to calls to encourage students to engage in inquiries, yet the number of questions posed by students remains modest and typically low. In light of these observations, it is recommended that teacher education curricula and professional development seminars undergo a restructuring to prioritize the affective and pedagogical dimensions of questioning skills.

Sezen-Barrie et al. (2019) examined "wondering questions" generated by students in the context of climate change and investigated how these questions affect teachers' teaching approaches. In the study, student-generated questions were divided into three main categories: questions related to direct observations, questions that aimed to make interdisciplinary connections, and questions that included projections about the future. It was emphasized that student questions contributed to their conceptual understanding of climate change and allowed teachers to improve their pedagogical practices. According to the findings of the article, students' asking such questions helps them to develop their science process skills, while at the same time increasing classroom interactions. Teachers' responses to these questions and their reflections contributed to more effective planning of climate change education. In particular, it was stated that teachers made learning processes more meaningful by taking students' questions into consideration and that these questions guided future educational practices.

Vale (2013) asserts that the act of posing inquiries constitutes an essential element of the scientific method and underscores the pivotal role that this aptitude plays in both educational settings and scientific research endeavors. The study posits that the propensity to inquire arises from an innate curiosity in young individuals; however, educational systems frequently hinder this innate process through rote memorization-based approaches. The text emphasizes that questions are essential tools that support students' meaningful learning processes and that science education, in particular, should be transformed into a more inquiry-oriented structure to encourage students' curiosity and enable them to think critically. It is further asserted that the ability to pose questions is a pivotal skill not only for students but also for scientists, with the foundation of successful research being the formulation of a compelling question.

Gautier and Solomon's (2005) research yielded findings that underscore the pivotal function of students' inquiry processes in fostering comprehension of scientific principles and cultivating critical thinking skills essential for problem-solving in environmental contexts. The researchers further emphasized that students develop the capacity to generate their own questions and participate in scientific processes through these questions rather than merely repeating existing knowledge. However, the efficacy of this process hinges upon the provision of teacher guidance and a structured learning environment. The article further demonstrates that the ability to pose questions not only reinforces students' individual learning capacities but also fosters their collaborative abilities and the identification of shared solutions within a community. This learning model enhances environmental awareness by enabling students to cultivate a solution-oriented thinking process through inquiries into complex and multidimensional issues, such as climate change. The study's findings suggest that educators and policymakers should purposefully design and support question-asking processes.

Table 2. Main ideas of the articles about questioning in climate change education

Articles	Main ideas of Article
Nusche et al. (2024)	Questioning and educational change in CCE
Sabarwal et al. (2024)	Information gaps and importance of education
Vaughter (2016)	Questions for effective solutions
Brass and Mazzarella (2015)	Design education and questioning in CCE
Özdem et al. (2014)	Students' questions' importance for CCE
Jordan et al. (2023)	Students' questions' importance for CCE
Stevenson et al. (2017)	Need for education about questioning in CCE
Newsome et al. (2023)	Questioning for CCE
Sihvonen et al. (2023)	Students' questioning in CCE
Monroe et al. (2019)	Students' questions needed in CCE

In summary, it is seen that the articles examined under the title of questioning in education address the questioning process separately as teacher and student. In these articles, different teaching techniques, teacher-student relationships, other skills gained by questioning and the importance of questioning were mentioned. The guiding effect of the teacher's questions, the effect of the teacher's answers and gestures were also mentioned, and the levels of students' questions were also expressed. However, the articles do not include topics such as how questioning should be in education, how students and teachers should ask better questions, and the literature is limited to this.

Questioning in Climate Change Education

In the literature, the importance of questioning about climate change, it's facilitating the understanding of the complex nature of climate change and the impact of questioning has been mentioned. The articles under review were also examined in these dimensions. The reviewed studies and their main ideas are summarized in **Table 2**. Climate change education is abbreviated as CCE in that table.

According to the Nusche et al. (2024) which is titled as "Rethinking education in the context of climate change: Leverage points for transformative change", education systems have the potential to provide students with the opportunity to understand environmental problems from their own living spaces and to generate meaningful questions in this context by engaging with local contexts. This pedagogical approach has the potential to enhance students' capacity to devise effective solutions, both at the individual level and within communities. The report emphasizes the importance of

questioning processes as a pedagogical strategy, instructing educators to utilize this method to interrogate established knowledge and cultivate comprehension of intricate systems. Furthermore, it underscores the necessity for educational institutions to implement structural modifications to foster these inquiry-based processes.

Another report by Sabarwal (2024) demonstrates that education is a powerful yet underutilized instrument for climate action. The majority of individuals encounter an information gap, defined as a lack of knowledge regarding how to take action or the presence of misinformation. Teachers, as key players in this endeavor, can also have information gaps. The objective of climate change education is to empower individuals to acquire knowledge about environmental issues and to take meaningful action based on this knowledge. In addition to increasing knowledge and awareness about climate change, education should focus on the processes of how to make this knowledge applicable.

Vaughter (2016) underscores the necessity for climate change education to impart skills that can affect behavioral change in individuals and societies, as opposed to an exclusive emphasis on knowledge transmission. The study asserts that the disparity between knowledge and action should be mitigated, and in this regard, education should transition from a focus on "knowing how to learn" to an emphasis on "doing how to learn." To achieve this transformation, it is emphasized that curriculum policies should adopt a solution-oriented "action competence" model, complementing the development of students' critical thinking skills. The study further asserts that citizenship education is a particularly effective instrument in fostering individuals' capacity to formulate and execute solutions in the context of climate change. In this regard, it is imperative that students engage in action at both the local and global levels, while demonstrating a comprehensive understanding of the environmental, social, and economic contexts that inform these issues. Integrating inquiry processes into the learning environment is identified as a pivotal strategy to facilitate student comprehension of intricate environmental issues and cultivate effective solutions.

Brass and Mazzarella (2015) discuss the role of design education in cultivating the capacity for inquiry, a skill that is equally applicable in the context of climate change education. Specifically, the ability to pose the appropriate inquiries emerges as a pivotal element in both design and climate change education. Within the design process, students are encouraged to approach problem-solving through creative means. The utilization of inquiry-based strategies in the design process fosters students' ability to analyze complex environmental challenges from multiple perspectives and devise effective solutions. Correspondingly, the objective of climate change education is to cultivate students' scientific inquiry and critical thinking skills, ensuring their active engagement in social transformation and sustainability. These innovative approaches in design education offer a valuable framework for enhancing climate change education.

The study by Özdem et al. (2014) demonstrates the potential for more effective utilization of students' perceptions about climate change in educational processes. The study's findings indicate that students perceive modern life as the predominant cause of climate change, yet they perceive their individual actions as ineffective in addressing it. The study underscores the significance of questioning processes as a pedagogical tool, highlighting their potential to address students' misconceptions and address gaps in their understanding. The study indicates that teacher-guided inquiry activities can facilitate more in-depth learning processes concerning environmental issues for students. Furthermore, the study underscores the pivotal role of climate change education in fostering a heightened awareness among students, both as individuals and as members of society, by means of these interrogative techniques.

It is crucial for climate change education to incorporate a process of inquiry to facilitate students' comprehension and further their grasp of environmental knowledge. A study by Jordan et al. (2023) revealed that students' knowledge about climate change is generally rudimentary, indicating a need to transform this knowledge into more complex thinking processes. The study underscores the imperative for the implementation of effective questioning techniques to enhance students' knowledge levels and to facilitate their learning processes. The study further underscores the importance of cultivating students' questioning skills by addressing complex issues, particularly the causes and effects of climate change. The study's findings indicate that students' inquiries concerning climate change are in number limited and frequently superficial, underscoring the need for enhanced educational support.

Stevenson et al. (2017) emphasize that climate change education should encourage young people not only to acquire environmental knowledge but also to interact with it, question it and ask critical questions. In the study, it was stated that the focus should be on developing critical and creative thinking skills so that students can make sense of a complex issue such as climate change and determine appropriate actions in this context. Determining what students and teachers understand about climate change is seen as the first step in creating an effective education program. This process requires a learning environment enriched with an interdisciplinary approach that develops students' and teachers' questioning skills. The article emphasizes that questioning processes make it possible not only to acquire knowledge but also to transform this knowledge into meaningful actions at individual and societal levels.

Climate change education should aim not only to transfer knowledge, but also to develop students' critical thinking skills and engage them in active inquiry processes. The study by Newsome et al. (2023) emphasizes that with an effective education system, it is possible for students to develop sustainable consumption habits and become individuals who can produce solutions against climate change. It is stated that questioning processes are a critical mechanism that strengthens learning not only at the individual level but also in terms of social awareness and responsibility.

Sihvonen et al. (2023) examined students' potential to use questioning approaches in climate change education and the role of teachers in this process. The study reveals teachers' professional development processes, how they can guide students' questions and how these questions can affect learning processes. The study emphasizes that student

questions contribute not only to the process of acquiring knowledge but also to the development of critical thinking and problem-solving skills. Teachers were observed to make the learning environment more interactive and student-centered by using student-generated questions. For example, students' generating questions about events related to global warming and discussing and answering these questions in the classroom supported both individual and group learning. The study also suggests that question-asking processes improve students' science process skills and enable them to address more complex environmental issues. In this context, teachers' professional development processes and teaching methods were enriched with questioning-based approaches. The study shows that teachers can contribute more effectively to students' learning processes by adopting these methods. Moreover, enhancing teachers' pedagogical competencies and involving students in active learning processes in this context is considered critical for the effective implementation of climate change education.

Climate change education necessitates the implementation of effective strategies to cultivate students' critical thinking and problem-solving skills regarding environmental issues. Lastly, a systematic review by Monroe et al. (2019) identified four key themes that have been identified as contributing to the success of educational programs in this domain. These themes include the incorporation of personal meaningful and relevant information, the utilization of participatory and active teaching methods, the addressing of misconceptions, and the integration of community-based projects. Of particular note is the efficacy of student-centered approaches and projects in local contexts, which have been shown to enhance engagement by rendering the learning experience more meaningful. However, the study identified a significant gap in research, particularly concerning effective questioning techniques in the context of climate change education. These findings underscore the significance of structured questioning processes and the promotion of student engagement in active roles within these processes.

To sum up, it is seen that the articles examined under the title of questioning in climate change education address the difficulties in teaching and understanding of climate change, the existence of local and global problems of climate change and the importance of teacher and student questions. In addition to these, the inadequacy of education modules and the gaps in the literature on this subject were also mentioned in the articles.

DISCUSSION AND CONCLUSION

Questioning is an essential teaching method not only in education but also in science education and climate change education, which occupies an important place in science education. In this study, 20 articles on questioning in education and questioning in climate change education were reviewed and the findings from these articles were synthesized. The reviewed articles divided the questions into teacher questions and student questions, but student questions were less common. The articles mostly mentioned the challenging and complex nature of climate change and the importance of questioning but did not mention how to apply it correctly (Brass & Mazzarella, 2015; Chin, 2007; Gautier & Solomon, 2005; Jordan et al., 2023; Sihvonen et al., 2023; Stevenson et al., 2017; Tolppanen & Aksela, 2018).

In addition to teacher questions, the articles also emphasized the importance of the teacher's demeanor when asking questions or answering students' questions but did not elaborate on how the teacher can guide students to the right questions. Regarding climate change education, while it is mentioned that the subject is difficult to understand even by teachers and that more effective learning can be achieved by providing local and global effects through questions, no details are given on how this education should be planned. It was frequently emphasized in the articles that there is a com in this regard (Monroe et al., 2019; Özdem et al., 2014; Sabarwal et al., 2024).

Since there are not enough articles in the literature on this subject, the number of journal articles examined, and the number of database resources used can be shown as limitations. In future studies, it may be necessary to increase the scope to reach more journal articles in this field by using different keywords and to show the findings in a wider range. In this study, journal articles published in the last twenty years (2004-2024) were selected as data sources. However, the period can be extended in future studies. The study has some recommendations for stakeholders such as teachers, parents, schools and decision makers in the context of climate change education. Training can be provided to understand teachers' knowledge and misconceptions about climate change and to improve them in this area. Teachers and students could be provided with information on how to ask better questions, and lesson plans could be developed for questioning. Also, questioning is not only related to climate change, but educational methods can also be studied to ask the right questions in education and thus develop different perspectives. Finally, since it is known that questioning starts at a young age with “what” and “why” questions, parents can be trained on how to communicate with their children and find the right questions and answers.

In reaching a conclusion, this study makes an important contribution to the relevant literature, which is the intersection of science education, climate change education, and inquiry-based pedagogy. Inquiry constitutes a vital skill that ought to be cultivated in both the context of education in general and that of global climate change education. The study reveals a gap in existing research and in implementation. In the context of global climate change education, there is a pressing need to implement teaching strategies that foster the development of students' skills, including curiosity, critical thinking, and problem-solving abilities. The numerous features of this study will serve as a foundation for subsequent research, educational initiatives, and curriculum development in future studies.

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