



Curiosity in Learning Biology: Literature Review

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Abstract

Previous research has shown that curiosity has an important role in education, especially in learning biological sciences. This review of literature study aims to examine the important role of curiosity in learning biological sciences. The focus in the study is 1) the nature of curiosity, 2) curiosity research in learning, and 3) curiosity in learning. The results of the study that curiosity has a positive contribution to learning include; 1) increase motivation and interest in learning, 2) develop critical thinking skills, creative thinking skills, and improve academic achievement. Curiosity can be developed and enhanced in learning by using problem Based Learning Models (PBL), Project-Based Learning (PjBL), Inquiry, and Discovery Learning.

Keywords: Curiosity, learning biology, motivation, learning outcomes

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INTRODUCTION

The development of science and technology in the era of the industrial revolution requires individuals to have high-order thinking skills and the character of curiosity. (Bialik et al., 2015) Curiosity is one of the characters that must be developed in 21st century learning (Rowson et al., 2012) the foundation of education. (Fadilah & Kartini, 2019) In the 21st century, character education is needed to form students who are not only intelligent in knowledge but also intelligent in character. There are 18 national cultural characters that have been initiated by the government, one of these characters is curiosity (Hartono, 2014). Fostering curiosity is the goal of education because it allows them to facilitate their involvement in authentic and meaningful learning, both inside and outside the classroom. Curiosity serves as a starting point for discovering new concepts and ideas (Hayumuti et al., 2017) through study and observation. In the cognitive domain, curiosity has the benefit of creating critical thinking and creative thinking skills.

Curiosity is defined as the desire to know, see, experience, and motivate exploratory behavior directed at the acquisition of new knowledge and sensory experiences. (J. Litman, 2005; Raka, 2011; Shiau & Wu, 2013). (Binson, 2009; Sinha et al., 2017) Curiosity is an important part of the disposition process to ask questions, scientific investigations, and become metacognitive skills. (Gottlieb et al., 2013; Lydon-Staley et al., 2021) Curiosity is

characterized by intrinsic motivation for information seeking. The character of curiosity is a driver of intrinsic motivation to gain understanding, knowledge, and experience through the process of investigation. Curiosity is the need of every individual to study and explore science such as science. (Luce & Hsi, 2015) Every discipline that is explored by everyone requires a high curiosity.

Curiosity is an important part of learning biology. (Jirout, 2020) Curiosity is very much needed in science learning to make it easier to carry out scientific activities such as scientific discoveries and innovations. (Dubey & Griffiths, 2020) essence of science and an integral component of cognition. Biological science is the science that studies nature and all its contents (Hw, 2012). Science is obtained through a series of scientific activities that are used to obtain a number of facts, concepts, principles, and laws about nature. The scientific process leads to a series of logical steps taken by scientists when they want to answer their curiosity about nature and when they want to find solutions to the scientific problems they face (Carin, 1993). Biology as a science should be directed at providing experiences that involve minds-on, hands-on, and hearts. Therefore, the ideal Biology learning is not only by transferring knowledge, but also involving the active role of students to get concepts in depth. To be able to teach biology well, intrinsic motivation is needed in the form of curiosity. (Zion & Sadeh, 2007) Biology is related to natural phenomena that can stimulate thinking skills and stimulate curiosity. With (Wulandari et al., 2020) forming the character of curiosity in science, learning is expected to be able to equip students with the ability to think, do scientific work, and solve problems in everyday life.

Curiosity plays an important role in developing students' motivation and desire to learn. (Saridevita et al., 2020; Shellnut, 2006) The attitude of curiosity is needed by students to encourage motivation so that students are interested in learning and digging up information in teaching and learning activities. Curiosity will grow if the atmosphere in the classroom is made as interesting as possible. (Wulandari et al., 2020) It is also important to take action by educators in the form of encouragement to increase student curiosity. Both in terms of learning strategies, learning methods, the use of learning media used in the process of teaching and learning activities in the classroom, as well as actions that can motivate these students to be more enthusiastic and focused in learning. (Novelyya, 2019) The high curiosity that a student has will increase the learning activities of a subject, and become a better student (Cain, 2019; Mouromadhoni et al., 2019; Mussel, 2013; Shellnut, 2006) the important character that must be developed in learning.

This study is expected to provide benefits in answering questions about the nature of curiosity in learning, the role, and the benefits of curiosity in the teaching and learning process so that it can be the basis for developing student curiosity in the learning process.

METHOD

The method used in the review is a literature study, referring to (Oam, 2007) Literature study is conducted by surveying various primary references that have relevance to the problem, field of study, theory, and the subject being reviewed. Literature studies are designed to provide an overview of the sources that have been explored when researching/studying a particular topic and to show the reader their suitability to a larger aspect of the topic. (Budiyanto et al., 2020).

The author reviews various primary literature. Search through online media via google. Literature sources from national, international scientific journals, and Proceedings. To ensure the authenticity of the author's source only use sources that have a URL and DOI. To make it easier to prove the search, the author uses reference management with the Zotero application.

RESULTS AND DISCUSSION

The Nature of Curiosity

Humans as social beings who are equipped with intelligence, the ability to think, and have curiosity make each individual human being able to survive. Curiosity is the starting point of knowledge possessed by everyone (Hayumuti et al., 2017). (Binson, 2009; Nugroho, 2019; Suhadak, 2014) A person's curiosity is a manifestation of an individual's enthusiastic attitude by observing, investigating, listening, seeking, and digging information to obtain the truth of phenomena or objects in their environment. (J. Litman & Spielberger, 2003) Curiosity is the desire of every individual to obtain new information and knowledge.

Curiosity was first conceptualized by Berlyne (1954) into two behaviors, namely perceptual exploration and epistemic exploration. (Berlyne, 1954). (Piaget, 2001) describes curiosity as a simple emulsion, and as a need to explain the unexpected. In the (World Economic Forum, 2015) Curiosity and initiative serve as a starting point for discovering new concepts, ideas, and (Zetriuslita & Wahyudin, 2018; Zetriuslita et al., 2017) stimulate creative thinking. (Elliott, 2000) Curiosity can stimulate, encourage and build students' knowledge.

Curiosity is an important basic aspect that encourages students' motivation in finding various information which in turn helps them to understand the concepts being studied (Dewey, 1997; Lamnina & Chase, 2019; Mouromadhoni et al., 2019). Desire to be a strong driver of the need, thirst, or desire to know, see and the motivation for study behavior to get new information that comes from uncertainty in students which causes conceptual conflict in students (Hayumuti et al., 2017). Furthermore, Mouromadhoni Curiosity is also an important part of the character and must be developed in learning, if this curiosity can be put to good use then students can understand the phenomena that occur around them and be more critical in finding a concept, and (Marvin & Shohamy, 2016) improve retention of information in long-term memory.

Daniel Berlyne (1954) dividing curiosity into four dimensions, among others; (1) epistemic curiosity, epistemic curiosity refers to a person's response through the knowledge he has acquired (it has), consisting of several components, observation, thinking, consulting (Madsen, 1981). Observation: includes a person's response to his contact with (to) real situations (conditions), for example during the learning process. Ex: I ignore objects that are around me, Thinking: includes someone's productive thinking or creative thinking to gain permanent knowledge or new knowledge, and Consultation: shows a person's response from others, either verbally or non-verbally (including in submissions). questions) by letter (email), (2) Perceptual curiosity, describing attention to new objects in the surrounding environment that arouse (Rowson et al., 2012) by complex or ambiguous sensory patterns of stimulation (eg sights, sounds), motivated behavior such as a visual inspection to acquire new information. (Koo & Choi, 2009) The curiosity that can increase perception is generated by complex stimulus patterns, such as sound (hearing), sight, motivated behavior such as sensory examination to obtain new information/knowledge. (Renner, 2007) Acquiring information/knowledge by sensory stimuli (sight, hearing), (3) specific curiosity (exploratory motivation in solving certain problems to reduce uncertainty and create a sense of mastery) (Hagtvedt et al., 2019; J. A. Litman & Jimerson, 2004), (4) *Diversive curiosity (various curiosity to explore knowledge and information)* (Rowson et al., 2012).

Curiosity indicators have been developed and described in detail, one of which is Kemendiknas (2020) and several researchers. The formulation of indicators and the form of instruments developed are presented in table 1. The following;

Table 1. Curiosity indicator

No	Source	Indicator
1	Mendiknas 2010	<ol style="list-style-type: none"> 1. Ask the teacher and friends about the learning materials; 2. Asking something about certain symptoms that occur; 3. Ask the teacher about what they hear from anywhere,

		both from the family and the media;
		4. Asking other reading sources other than textbooks about the material to be studied;
		5. Read and discuss recent natural phenomena; and
		6. Read and discuss some new natural, social, economic, political, and technological events that have just been heard
2	Todd B. Kashdan	1. Stracing 2. Embracing 1. Joyous exploration: 2. Deprivation sensitivity 3. Stress tolerance: (entire subscale reverse-scored) 4. Social curiosity: 5. Thrill seeking:
3	Jennifer L. Weible Heather Toomey Zimmerman	1. Stracing 2. Embracing 3. Sains Praltik
4	Maya Bialik Michael Bogan Charles Fadel Michaela Horvathova	1. Open Mind, 2. Exploration, 3. Passion, 4. Self-Direction, 5. Motivation, 6. Initiatives, 7. Innovations, 8. Enthusiasm, 9. Wonders, 10. Awards, 11. Spontaneity
5	Daniel Berlyne (1960)	1. Epistemik Curiosity 2. Perceptual Curiosity 3. Specific Curiosity 4. Diversive Curiosity
6	Steven Raharj, Steven Raharj, & Steven Raharj (Beswick & Tallmadge, 1971)	1. Explore, 2. Discover, 3. Adventurous, 4. Questioning 1. Surprise, 2. Doubt 3. Perplexity 4. Contradiction 5. Bafflement 6. Cognitive 7. Conflict 8. Novelty 9. Complexity 10. Incongruity 11. Ambiguity 12. Lack Of Clarity 13. Change.

Curiosity research results

After reviewing several research articles on curiosity, the research can present a summary of the results of the research. Curiosity contributes to students' willingness and courage to ask questions (Wulandari et al., 2020). Student curiosity helps initiate scientific exploration and inquiry, stimulate deep thinking and reasoning, and increases student motivation and interest in science (Chin & Osborne, 2008). The curiosity that students have can be a driving force in finding relationships between concepts so as to find new concepts (Widiastuti & Santosa, 2014). (Ainley, 2007; Clark et al., 2019; Ryan & Deci, 2013; Silvia, 2008) that curiosity positively contributes to the level of attention, concentration, exploration, questioning skills, understanding, and skills in learning.

Research conducted (Nafisa et al., 2021) shows that students' critical thinking skills seen from curiosity show variations. High student curiosity reached the categories of high, medium, and low critical thinking abilities. Students' curiosity is reaching the categories of high, medium, and low critical thinking abilities. Meanwhile, students with low curiosity reached the category of low critical thinking skills. The same results are shown by the results of research conducted (Permanawati et al., 2018) namely a) students with all levels of curiosity are able to answer questions to determine facts and identify/formulate question indicators but are less able to identify/control irrelevant things and accept or reject decision indicators; b) subjects with high and moderate curiosity are able to answer questions, provide logical thinking, answer "why" questions and present conclusions; students describe/help explain the fact indicators. However, subjects with low curiosity are less able to answer questions from these indicators.

In terms of gender, it shows (Hanshaw-King & Shari, 2004) that men are more likely to act on their curiosity than women. (Nugroho, 2019) there is a significant difference between the curiosity of boys and girls. In addition, it can be seen that the average value of curiosity in male adolescents is 36.40 higher than female adolescents with an average curiosity value of only 33.76. This study uses the Curiosity and Exploration Inventory which was developed by Kashdan, et.al (2009). (Raharja et al., 2018) The level of education and gender did not affect students' curiosity and the average curiosity of students and students did not differ significantly

Curiosity and learning process

Curiosity is a basic part that must be possessed by students in the learning process, the existence of this curiosity can be a driving force for enthusiasm and effort in the learning process. (Berlyne, 1954) states that curiosity is an important component of learning, and an important part of cognitive development as well as a condition of knowledge growth (Camp, 1986). (Mouromadhoni et al., 2019) stated that curiosity is an important basic aspect that encourages students to find various information which in turn helps them to cover the concepts being studied.

Disciplines require curiosity (Luce & Hsi, 2015) which is an important part of school science programs that aim to develop students' scientific literacy. (Millar, 2014). In order for teachers to develop students' scientific literacy through fostering curiosity, teachers need to use various pedagogical approaches (Higgins & Moeed, 2017).

Curiosity in students will make the knowledge they have meaningful (Sanjaya, 2013). Curiosity is an important part of the learning process because it can encourage the realization of meaning in learning so that curiosity is the soul and nature of learning culture. (Pluck & Johnson, 2011) curiosity is stimulated to increase meaningful learning. The existence of curiosity in students will have an impact on the desire to seek answers to any conditions that are contradictory to their thoughts until they get satisfaction or certainty about the questions that arise. (Grossnickle, 2016) states that curiosity is driven by the goal of seeking resolution and filling certain knowledge gaps. The most common is curiosity as a need for knowledge or information, and curiosity as a motivator for exploratory behavior. Since curiosity helps

learners to direct and regulate their attention to new information and embrace new uncertain experiences, it is an important aspect of learning (Pekrun & Linnenbrink-Garcia, 2014)

(Rowson et al., 2012) in *The Power Of Curiosity* explains that curiosity can be developed in learning at school in several ways, including;

1. A teaching process that develops competence and the disposition of curiosity as a learning goal, not just as a guaranteed benefit
2. Encourages mental forms of attention, including mindfulness, it makes us more curious about things we previously didn't pay attention to
3. Focusing and providing opportunities for students to learn something in-depth
4. Experiment by keeping learning outcomes open to making learning more exploratory
5. Encourage reflexive awareness of students' own nature and learning patterns.
6. Stay alert about the impact of technology on different types of curiosity

The importance of curiosity in learning is the focus of researchers to examine learning models that can teach and increase students' curiosity in learning. Research conducted by (Ertando et al., 2019) shows that one of the models that can be used to teach the four dimensions of curiosity developed by Daniel Berlyne is to use the guided inquiry model. (Nurfauziah & Sugiharto, 2015) the application of guided inquiry in biology learning can increase students' curiosity. (Widiastuti & Santosa, 2014) Learning with the inquiry learning method is superior to conventional learning methods in terms of achieving basic competencies, curiosity, and mathematical reasoning abilities. (Winarni, 2019) the application of the Discovery Learning model can increase learning activities, curiosity attitudes, and care for the environment/health of S-2 Elementary Education FKIP UNIB students in Basic Education Science lectures. Research conducted by (Rusilawati, 2016) shows that scientific attitudes in the dimension of student curiosity can be improved by using a synthetic approach with the aid of teaching aids. (Mouromadhoni et al., 2019) the results of his research show that curiosity can be developed through science learning with an authentic inquiry learning approach. (Pluck & Johnson, 2011) problem-based learning can stimulate effective student curiosity. (Suhirman et al., 2021) Critical thinking skills and students' curiosity can be improved by using the Problem-Based Learning with Character-Emphasis (PBL-CE) learning model. PBL-CE can be applied as alternative learning in biology learning to develop critical thinking and curiosity.

The learning model that can be used in teaching curiosity is Project-Based Learning (PjBL). (Wicaksana, 2018) states that PjBL can provide further learning experiences and provide challenges to students so that it has a positive effect on increasing students' epistemic curiosity character. Meanwhile (Clark et al., 2019) said that adolescent dispositional curiosity could be significantly increased by implementing student question brainstorming interventions through direct teaching.

In research conducted (Nafisa et al., 2021) using independent learning assisted by modules is effective in improving critical thinking skills and student curiosity. (Zetriuslita et al., 2020) curiosity and critical thinking skills can be facilitated by the Problem-Based Learning and Cognitive Conflict Strategy (PBLCCS) learning model.

The results of the study illustrate that curiosity can be developed and enhanced through learning models that emphasize scientific activities such as observing, observing, and analyzing.

CONCLUSION

Curiosity is the driving force of motivation, interest in learning through observation activities, Curiosity is divided into four dimensions namely; 1) epistemic curiosity, 2) perceptual curiosity, 3) specific curiosity, and 4) diversive curiosity. Several studies have shown that curiosity can have a positive effect on students' academic achievement, critical thinking skills and creative thinking.

RECOMMENDATION

The study of the curiosity of biology education students needs to be explored and analyzed using a curiosity instrument that includes four dimensions of curiosity, with the aim of being able to provide learning to students according to their needs. In addition, it is necessary to integrate curiosity into learning models and learning tools that can support the formation of curiosity such as PBL, Inquire, CTL and BjBL.

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