Book Review

Children's Ideas in Science

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Editors: Rosalind Driver, Edith Guesne and Andree Tiberghien
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With the advent of globalisation, science and technology has become a significant or rather indispensable part of our life. And to advance in the modern age of innovation, we need to empower ourselves with the 21st century skills and should learn the know-how of inquiry-based science education. On considering equipping with the 21st century skills, several important questions arise, should science be taught differently in classrooms? What if the teacher needs to emphasise upon the process or the outcome? And the most significant question is about the child's psychology, i.e., how do they learn? The book, *Children's Ideas in Science,* tries to answer these critical questions and traverse through the secondary school children's ideas that are in the age group of 10–16 years, on a range of natural phenomena such as light, heat, force, motion, the structure of matter and electricity. The book intents to unveil the journey of understanding and shifting frames of knowledge of these children on the various topics of science, well illustrated and exemplified in its various chapters, depicting how these ideas change and develop with teaching.

It tries to widen the scope for reflective teaching practices for both

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teachers and teacher educators for the cultivation of student-centric, outcome-based learning as highly recommended by NEP 2020. The book seems to be well-organised and reader-friendly and has been divided into 10 chapters briefly painting the different frames of classroom scenarios tie-in with constructivism and connectivism learning theories.

Chapter 1 titled, 'Children's Ideas and the Science Learning' describes that students' minds are not blank slates and the children arrive in their science classroom with their own ideas and interpretations of phenomena even when they have received no systematic instruction on these subjects. These ideas and interpretations, are either a natural result of their daily experience of physical activities or social interactions or exposure to media. Thus, their thought process can give diverse interpretations on the same topic as a manifestation of their previously acquired notions and their exposure to new concepts taught in the class. Their learning experience is immensely influenced by the way new information is acquired and the way in which scientific knowledge is generated. Several examples have been cited throughout the book to illustrate that students don't modify their ideas soon after the attempt made by the teacher, who challenges their ideas by offering them counter evidence but instead; students may either ignore the counter-evidence or interpret it in terms of their prior ideas. In Chapter 2 titled, 'Light', the author conducted an experimental study on school children of various countries related to the topics—light and shadow, light and daylight and light and vision, it highlights the differences in perception of children for an entity—'light'. The analysis of study was done at multiple levels, i.e., individual level, within an age group and across age groups which clearly demarcated the differences in their perceptions. The results added for understanding that the same child perceived the concept differently when his/her age increased while children in the same age group showed different perceptions and thought processes for the same entity but they did have a clear limit regarding the depth of their perception. And at the third level, children in higher age groups clearly had a higher depth of thought and perception about the same physical entity—light.

The pedagogical implications that can be stated would be in terms of the efforts required by a teacher to develop and nurture the thought process of students in different age groups but within the limitation of their natural age and biological thinking limits. Pushing students to think beyond their natural capacities at tender ages can also be counter-productive to their overall development. The pupil should not be forced to learn a concept, but instead there should be a gradual ramp-up of thought-building encouraged

by the teacher through the thought-provoking questioning as with gradual learning, reading, age and maturity, students would naturally progress in their level of thinking individually.

There are many topics in science that children find difficult to learn and undoubtedly electricity is one of them. What is suggested in Chapter 3 of the book titled *Electricity in Simple Circuit* is in line to Jean Piaget's theory of cognitive development advocating the use of analogies as pedagogical tool for teaching children in concrete operational stage. Since, children in concrete operational stage cannot be expected to transfer logical deductions readily from one physical system to another, thus, the author advocates the use of analogies especially for transacting difficult topics for easy, effective and relatable learning. Chapter 4 titled, 'Heat and Temperature' provides an overview of pupils' ideas on the phenomenon of heat and temperature and sheds light on the way pupils shift their frames of knowledge on a concept with classroom teaching. Another important observation made by the authors discussed in Chapter 5 of the book explains that children often make their own models of science concepts based on their general observations and ideas from their day-to-day routine. These models may differ from those taught in books and by teachers. Therefore, teachers should create a conducive and open to learn classroom environment for their children to foster their free thinking. The author also states that language plays a most prominent role in teaching and learning and advice teachers to use language that students can relate to and connect with their daily experiences. Furthermore, teachers should understand that children have different levels of knowledge and should often practice teaching methods like discussion and debate to aid their understanding. Additionally, the chapter highlights the importance of introducing real-world materials to students before they do experiments to foster the need to use the laboratory qualitatively rather than quantitatively. Chapter 6 titled, 'The Gaseous State' exhibits common teaching mistakes and challenges faced by the Teachers while transacting a topic with broad array of concepts. In Chapter 7, the particular nature of matter in the gaseous state is in continuation to the study done by the authors in Chapter 6 where the authors conducted case studies in different countries to investigate and explore the difficulties confronted by pupils in understanding and learning behaviour of gases and its properties. The descriptions and arguments intended to stimulate awareness and sensitivity to pupils' alternative beliefs regarding the structure of matter and its particulate nature and its particulate nature. Lessons taught from the deterministic nature of students' preconceptions prompt teachers to search for more effective

teaching strategies. Lessons taught from the deterministic nature of students' preconceptions prompt teachers to search for more effective teaching strategies. The study concludes that major conceptual change is initiated only as a result of conflict between children's pervious conceptions and contradictory suggestion. And in science teaching, teachers should create a free environment to use the conceptual conflict as a teaching aid to facilitate the students' centered learning where the student openly exposes and articulates their preconceptions. Moreover, by recognising the persistence of these preconceptions, educators can be motivated to search for more operational teaching methods. If we turn the pages further, Chapters 8–9 titled, 'Beyond Appearances: The Conservation of Matter under the Physics and Chemical Transformation,' and 'The Earth as a Cosmic Body', respectively explores the types of reasoning used by 11–16 year old children about three types of changes, i.e., change of state, the process of dissolving, and the process of burning. Studies of secondary school children's ideas about these phenomena have been undertaken in a number of countries including Britain, France, Sweden, and New Zealand. The findings of the study identified that scientific concepts are not internalised on the immediate basis as intended with their formal teaching in schools rather, primitive elements tend to persevere in children's notions for some time despite of formal instruction. Another important observation made by the authors during the study was that the science topics are typically taught based only on the subject matter, without analysing the cognitive demands presented by the topic which restraints effective learning. The book ends with Chapter 10 titled, 'Some Features of Children's Ideas and their Implications for Teaching', which concludes that students should base their reasoning on observational features in problem situations. The authors suggest that in curriculum designing process, it is necessary to consider not only the structure of the curriculum but also the learners' perspectives. Moreover, knowing the students' ideas is a key component in specific learning tasks and teachers should provide opportunities to the students to make their own ideas explicit, allowing them to practice their ideas in a variety of situations and asking Socratic questions to change the students' conceptual learning. Also, students should be motivated to explore their ideas through discussion with their peers in small groups or brainstorming in class which can help them to appreciate the possible lack of consistency in their own thinking and to reconstruct their ideas in a more coherent way. The chapter also highlights that integrating new concepts is a longer-term process, and it may be difficult to assess the

effectiveness of teaching in promoting conceptual change in the short term, therefore, teachers may need to adopt long-term goals for pupils' conceptual learning.

Children's Ideas in Education is an insightful and thought-provoking book which tries to explore the reverberation of the children's preconceptions, or preconceived ideas on their learning of a subject and argues that these preconceptions of children play a critical role in shaping their understanding of new concepts. The book's informative discourse and field reportage insist the teachers to be aware of these preconceptions to improve their teaching practice to effectively facilitate learning. Another key strength of the book is its ability to present complex ideas in a clear and accessible way by making it easy to understand even for those with no background in psychology or education. Overall, the opus is an excellent resource for teachers and educators who are looking to gain a deeper understanding of how children learn by providing a comprehensive overview of the role of children's preconceptions in learning. The book is well-researched, clearly written, and highly practical, making it an indispensable tool for anyone who is engrossed in education.

Other books by editor Rosland Driver includes *The Pupils as Scientists*, first published in 1983 and *Making Sense of Secondary Science*, published in 2014. These books try to explore the critical perception of children in the light of a variety of science lessons from biologically to Earth sciences with an aim to widen the purview for science classroom teaching. Thus, an insight into the conceptual world of children in science classrooms would make science teaching and learning more rewarding for both teachers and students.

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