Studies on Content Analysis of Science Textbooks: A Literature Review

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Abstract: This paper is a review paper; the review paper intends to briefly analyze progress in a specific area. In the present study, the researcher has surveyed the literature accessible on the content analysis of science textbooks from different countries. The present paper aims to explore the major focused area of science textbook analysis in the 21st Century, with this researcher surveyed 25 studies conducted between the years 2000 to 2018. The researcher categorized the surveyed literature based on six validation criteria of the science curriculum, proposed by the National Curriculum Framework 2005. The finding shows that the most concerned field of science textbook analysis in recent years is related to environmental and ethical issues. The available literature reviewed by the researcher also reveals, most studies confirm that science textbooks fail to serve the real purpose of science education.

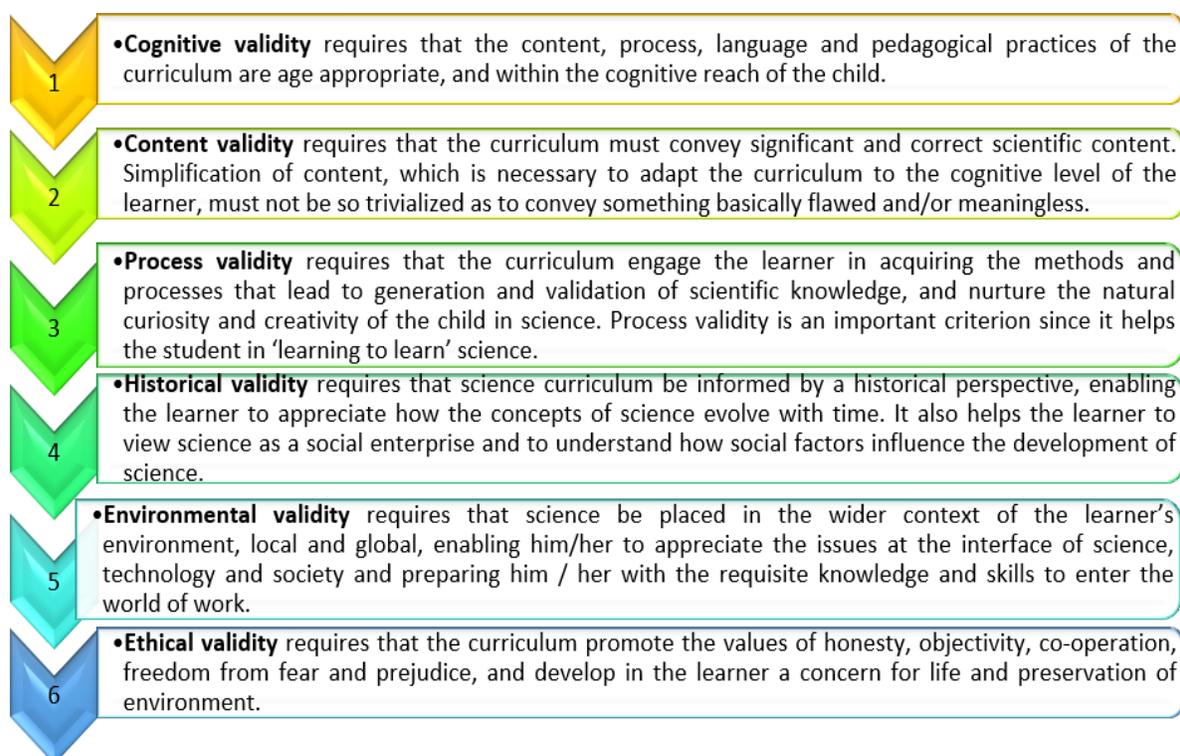*Key Words: Content Analysis, Science Textbook, Literature Review, Validity Criteria.*

Introduction:

Any form of researches is half-completed without a Literature survey. A literature review gives a sturdy base for any type of study. A careful review of the literature enables the researcher to gather and synthesize previous research related to the current study. Thus, in turn, this enables a researcher to identify wide overlaps and gaps between prior work (Singh,2018)**.** Keeping in mind the importance of a literature survey, in the present study researcher surveyed researches on content analysis of science textbooks. Regarding documentary research, content analysis, which simply means, analysis of the contents lying in a document. Its purpose is to determine important thoughts, topics, words, or other messages lying in it (Mangal, 2013). "Content analysis is a research technique for making replicable and valid inferences from data to their context" (Krippendorff, 1980). Simply it can be said that content analysis of textbooks refers to the analysis of texts related to theme, topics, messages imply in the book.

In any idealistic education system, the textbook is used as one of the major sources of curriculum transactions. According to Ogan-Bekiroğlu, 2007; Ünsan and Güneş, 2003, the textbook offers "teaching methods to teachers and direct students according to the course's objectives". Also, an important source for students to learning subjects independently, for revision of subjects, assessing themselves and available source for self-assessment (as cited in Erten, Şen & Yüzüak,2015). Similarly, according to Ninnes (2000) textbooks are a primary and important "aspect of students' experience in schools, they're often a very important contributor to students' ideas about the nature of science".

The rationale of the study:

The textbook of science is always playing an important role in determining what and how science should be taught. Science Textbooks are a significant resource used by teachers in most countries. Therefore, textbook analysis is important to recognize how science is presented. Science teachers accepted the importance of textbooks in teaching and learning methods (Koppal & Caldwell, 2004; Clement, 2008). The analysis of science textbooks differs by their readability and comprehensiveness, tailored to curricular needs, the suitability of students' age, intellectual level, appropriateness of explanations, a reflection of the teaching-learning process, needed time for teaching, the effect on the nonscientific belief of learners', even recognizing social prejudices in textbooks. Thus, it can be said that the analysis of the textbooks is important and necessary for any country to confirm the curriculum objectivity. McKinney (2013) found that textbooks are helpful for teachers in lesson planning and are an easily available resource of teaching-learning. So, for that, it seems compulsory to analyze the textbooks to understand how well the textbooks confirm the purpose of the course. As the textbook is the chief means to accomplish the purpose of any academic course (as cited in Ramnarain & Chanetsa,2016). Also, In India, for most school-going children, and also for teachers, the textbook is the only accessible and inexpensive curriculum resource. Subsequently, the textbook can be used as one of the principal tools for universalizing good science education in the country. In an advanced modern-thinking society, science can play a "liberating role, helping people out of the vicious circle of poverty, ignorance, and superstition" (NCF 2005), which can help to remove racism and imperialism, can overcome any kind of societal discrimination. Therefore, the curriculum of science should be such that can make children sensitive and aware of society. "Good science education is true to the child, true to life and true to science" (NCF, 2005). Keeping these philosophies of science education in mind, the National curriculum framework 2005(Serves as a guideline for curriculum, textbooks, and teaching practices for schools in India) proposed Six Validity Criteria for reforming the Science curriculum in India. Hence, the Indian curriculum of science education must follow six criteria of validity i.e., cognitive, content, process, historical, environmental, and ethical, and science textbook should be written accordingly.

Figure 1: Science Curriculum Validity Criteria Proposed by NCF 2005

1 • **Cognitive validity** requires that the content, process, language and pedagogical practices of the curriculum are age appropriate, and within the cognitive reach of the child.

2 • **Content validity** requires that the curriculum must convey significant and correct scientific content. Simplification of content, which is necessary to adapt the curriculum to the cognitive level of the learner, must not be so trivialized as to convey something basically flawed and/or meaningless.

3 • **Process validity** requires that the curriculum engage the learner in acquiring the methods and processes that lead to generation and validation of scientific knowledge, and nurture the natural curiosity and creativity of the child in science. Process validity is an important criterion since it helps the student in 'learning to learn' science.

4 • **Historical validity** requires that science curriculum be informed by a historical perspective, enabling the learner to appreciate how the concepts of science evolve with time. It also helps the learner to view science as a social enterprise and to understand how social factors influence the development of science.

5 • **Environmental validity** requires that science be placed in the wider context of the learner's environment, local and global, enabling him/her to appreciate the issues at the interface of science, technology and society and preparing him / her with the requisite knowledge and skills to enter the world of work.

6 • **Ethical validity** requires that the curriculum promote the values of honesty, objectivity, co-operation, freedom from fear and prejudice, and develop in the learner a concern for life and preservation of environment.

The above researches confirm (Ninnes,2000; Koppal & Caldwell, 2004; Clement, 2008; McKinney,2013) the importance of science textbooks and its analysis. NCF 2005 also considered the importance of science education and recommended validity criteria for validation of any science textbook because reforming of science curriculum promotes systematic restructuring of all the interrelated aspects of education i.e. syllabus, textbooks, classroom practices, evaluation criteria, etc. In every country, science education is considered an effective means to develop a scientific approach in learners so that they can create a world of equality. Which seems impossible without science textbooks that can develop valid and accurate scientific knowledge. Therefore, the analysis of the science textbook is very important. Realizing this, the researcher surveyed literature related to science textbook analysis and has been decided to write this review paper, aimed to find the answer, "what is the major focused areas of science textbook analysis in the 21st century and also to explore whether the Science books have been written in a way that fulfills the purpose of science education". Although NCF 2005 proposed these criteria for validation of the Indian science curriculum through figure 1 it is explicit that NCF has tried to cover all the main aspects of a good science curriculum within six criteria. Therefore, in the present study researcher categorized the surveyed literature into six validity types based on some salient features, which are related to particular validity criteria. In this study, the researcher has surveyed only easily online accessible researches from the year 2000 to 2018, which could also be the delimitations for this paper. The Researcher surveyed a total of 26 studies,12 Indian and 24 foreign studies respectively. The study's findings will be helpful for future textbook analysis researchers.

The Researcher found that textbooks have been studied from various dimensions in the related literature. Below is the category wise representation of surveyed researches on science textbooks analysis.

Studies related to Cognitive Validity: In 2015, Erten, Şen & Yüzüak analyzed the 5th-grade Elementary Science Education textbook and took teachers' opinions about the level of experiments in the textbook, compatibility with aims, correlation of subjects with daily life, and more. Findings showed that activities related to using tools in the experiment were not coherent with the student level. Tools used in activities such as matchsticks, sharp tools, harmful chemicals, etc. might be harmful to 5th-grade students.

Studies related to Content Validity: Deshmukh & Deshmukh (2011) conducted a study titled "Textbook: A Source of Students' Misconceptions at the Secondary School Level" for class X biology book of Maharashtra Board and Central Board. For the collection of data, the researcher conducted a test regarding misconceptions, interviewed students, and analyzed some important topics of the textbooks. Results revealed that students had misconceptions about these topics like the functioning of hearts & lungs, the difference between respiration and breathing, photosynthesis, and plant respiration because these topics were not undoubtedly explained in textbooks and not clearly explained by teachers too. Interview revealed misconceptions were also found based on social practices. Researchers recommended that science textbook writers should reduce the misconceptions because textbooks are traditionally used as reliable study material by students and teachers. Liu &Treagust (2013) analyzed the diagrams of secondary school science textbooks of Western Australia. The objective of the research was to observe the nature and number of diagrams in the textbook. Results revealed that "three categories of scientific diagrams (iconic, schematic, charts and graphs) have been identified, the most commonly used diagrammatic type is iconic i.e.,69.63 %, however schematic diagrams & charts and graphs used as 24.14 % and 6.24 %, respectively". It can be supposed that iconic pictures are easier to understand for beginners in science learning. Similarly, Qasim & Pandey (2017) observed "diagrammatic representations of upper primary

science textbooks based on pictorial typology" and found that upper primary level of science textbooks includes an inadequate number of diagrams, and also most of them were of iconic type. Qadeer (2013) analyzed Toronto's grade six textbook on electricity, to check the scientific explanation of the content and found that more sentences were "without reason-based", means maximum sentences lack to provide reasons, why any particular things happened. Though some daily life-related examples of electricity were found, the relations between electricity and electrons were not clearly explained.

Studies related to Process Validity: Sinha and Tripathy (2005) analyzed "secondary school science syllabi and science textbooks for classes IX and X of Bihar, Odisha, and West Bengal". The findings revealed that many of the ideas comprised in the syllabus and textbook were repeated, numerous unimportant materials were included, textbooks were failed to giving children the opportunity of 'learning to learn'. In 2007, Chiappetta & Fillman examined "five high school biology textbooks of U.S. to diagnose the inclusion of major dimension of the nature of science namely, science as a body of knowledge, science as a way of investigating, science as a way of thinking, and science and its interactions with technology and society". The findings of the study showed that a major portion of books presents science as a body of information and textbooks frequently inspired students to investigate. Senem (2013) studied the Turkish 9th-grade physics textbook to investigate the amount of presence of science process skills. The result showed that the 9th-grade physics textbook extremely included collecting and measuring data, however, ignoring hypotheses and defined-controlling variables. Alaghaa, Farajollahib & Shahmohammadi (2014), analyzed the content of the second-grade experimental science book based on areas of creativity. The findings of the study indicated that most attention in the distribution of sentences, pictures, and experiments was for convergent thinking, inadequate attention was for nurturing mental creativity i.e. Divergent thinking.

Studies related to Historical Validity: Ninnes (2000) specifically explored "secondary school science textbooks of Australia and Canada to examine representations of indigenous knowledge related to myths and legends, technology, the natural world, and social life". Although, findings revealed that both books present pretty extensive amounts of material related to indigenous knowledge from historical perspective i.e. how human beings started using of plants for making spears, how they started hunting, use of fire for shaping weapons, etc. However, the Science textbook in Australia comprises more indigenous information. In 2007, Chiappetta & Fillman examined five high school biology textbooks of the U.S. and found that most of the five biology textbooks emphasized on "how science is influenced by technology and society". A study by Ramnarain & Chanetsa (2016) explored the representation of the nature of science in South African Grade 9 natural science textbooks. The analysis exposed that textbooks reflect NOS poorly, particularly, "the social dimension of science, science vs. pseudoscience, and the 'myth' of scientific method" were noted. The researcher suggested that the school science curriculum must be improved with strong emphasis that highlights the learners' understanding of scientific enterprise and development of scientific knowledge. In 2018, Sundararaman examined the 8th and 9th-grade science textbooks published by the Karnataka Textbook Society, which was revised in the year 2012 based on NCF 2005. The researcher analyzed how and whether the nature of science in terms of the historical evolution of scientific concepts is presented by teachers and textbooks. The Findings of the study showed that science textbooks contain several verses in Sanskrit (also explained in English) for discussing the evolution of numerous scientific concepts. The textbook also provided more examples of Indian sages. Some of these verses and examples of sages were unnecessarily included in chapters that did not explicitly explain any scientific concepts. The study also revealed that the negative consequences of any invention were almost neglected by teachers.

Studies related to Environmental Validity: Ninnes (2000) also explored science textbooks for environmental validity and findings revealed that both books present quite extensive amounts of indigenous knowledge about the natural world like used of plants in pain relief, an idea about best weather for hunting, use of totem in conversation, and much more. In 2007, Chiappetta & Fillman also examined biology textbooks concerning environmental validity and found that STS received less attention while presenting the nature of science. In 2013, Rashid evaluated science textbooks of class VIII-X of UP Board in the context of environmental awareness. Results showed that the text-books implicit inadequate quantity of environmental facts and effects. There was no appropriate explanation about environmental issues namely, Greenhouse effect or Global warming, acid rains, and ozone layer depletion, etc. In the year 2013, Shahmohammadi analyzed the content of "Iranian science textbooks of elementary school to inspect the amount of attention these books pay to the motivation construct for the country's achievement". The findings of the study revealed that grade 3 and grade 5 textbooks had more focused content of motivation construct than 1, 2, 4-grade books. The most achievement motive constructs components were related to interest in continuing incomplete tasks, preservation, anticipating, and doing something well. The least emphasis on component of understanding of time, competency-based selection of friends, etc. In 2014, Morris explored the interpretation of SSI in the science curriculum in England. The researcher analyzed two SSI in Science textbooks focusing on the genetic technology of reproduction and climatic change in detail. Analysis of the science textbook showed a distinct difference from the perspectives of social science discipline on socio-scientific issues and the approaches taken in the textbooks. Babaei and Abdi (2014) studied the presence of components of emotional intelligence in textbooks of secondary school social studies and natural science. The results confirmed that EI components like social awareness in texts, "self-management in the exercises, and social skill in the illustrations"; were prevalent in social studies textbooks; whereas in natural science textbooks, these components were dealt casually. In 2015, Erten, Şen & Yüzüak analyzed the 5th-grade Elementary Science Education textbook, and the result revealed that coursebook contents were related to everyday life. In 2016, Mishra reviewed secondary level NCERT science textbooks to explore the inclusion of science, technology, environment, and society (STES) issues and found that an extensive range of STES issues have been dealt with, but not have a detailed explanation and examples from the real-life of the present situation. Also revealed that there was a scarcity of exposure to STES issues in many chapters. Questions and answers are mostly academically oriented and questions aiming at STES issues are of little importance. Gilavand, et al. (2016) observed the components related to health education in "science textbooks of Iranian junior high school course" through content analysis. Results proved that books paid the most attention to the management and prevention of diseases and the elements of "mental health".

Studies related to Ethical Validity: In 2000 Ninnes also explored the presentation of indigenous knowledge in science textbooks to overcome the ethnic, racist, and culturally imperialist view of knowledge. And found that Inclusion of an adequate number of indigenous knowledges develops a positive approach to dealing with racism, ethnicity, rooted in limited objectives of knowledge and cultural variety. The researcher suggested that indigenous people should be involved during textbook writing for the better and exact representation of indigenous knowledge, which helps to remove racism and imperialism. Roopa Rani (2008) explored the extent of values in IX standard science textbooks of NCERT. Analyzed the content using a checklist of epistemological, social, and personal values and confirmed that the values of epistemology hold a prominent place in the chemistry and physics parts of the textbook, while in biology, socio-cultural values were emphasized (both explicitly and implicitly). The values that have been focused on prominently in physics were "accuracy whereas in chemistry and biology it was analytical ability. From the textbook analysis, it had been found that some personal and socio-cultural values like team spirit, courage, confidence, equality, and co-operation have no place in the ninth standard science textbooks, although the curriculum frameworks emphasize them".   In 2017, Sharma examined the NCERT Science textbook of "6th grade to identify the underlying values in textbook and opportunity of developing necessary values in students". Findings showed that the content has an extensive number of explicit and implicit values in almost all the chapters, which must be taught significantly by the teachers while discussing chapters in the science classroom. So that the students can better understand these values and can reflect in their life. In ethical validity criteria, researchers found many studies related to **Gender Equity**: Elgar (2004) analyzed Bruneian science textbooks to investigate issues of gender equity. The researcher analyzed the book based on images, drawing and gender marked pronoun & noun. Results revealed that science textbooks show a clear gender inequity in photographs, texts, and illustrations. Jangaiah (2007) conducted a program on analyzing gender issues in Class 8, 9th, and 10th textbooks of the Andhra Pradesh government as reflected in NCF 2005. The findings showed that gender discrimination is seen in physical and biological science books. The textual content of science textbooks contains more masculine references. Based on the findings, the researcher suggested that textbook authors should give equal importance to both sexes and avoid stereotyping - content, pictures, activities, exercises, etc. Kahveci (2010) evaluated Turkish chemistry and science textbooks in terms of themes like gender fairness, level of questions, number of scientific vocabularies, and readability level. The findings showed that the textbooks did not provide satisfactory empirical evidence to gender equity and inquiry-based learning. Results also showed that cognitive level questions were more focused. Choudhary (2014) explored the status of women through food and curriculum and suggested that educational policy should focus on creating healthy and gender fairness textbooks as textbooks and curricula play a crucial character in encouraging women empowerment and also try to overcome all kinds of gender prejudices in the curriculum. It increases gender sensitivity in students. And also suggested that food culture should be the same for both men and women. In Karnataka, an exploratory and ethnographic study has been performed by Sundaraman (2018) to evaluate classroom teaching practices, science syllabi, and textbooks to find out how it relates to students' lives, contexts, and science learning settings. What types of experiences are promoted in whom, for whom are they addressed, especially what are the experiences of girls? Class observation, analysis of textbooks, and discussion were used. Analysis of the textbook and classroom observations revealed that attempts to draw the connection of science, environmental, social, and gender concerns were sporadic. There was hardly any representation of women scientists in the text.

Tron (2016) conducted, "a study of science education in the secondary schools of Meghalaya" and also analyzed the science syllabus of secondary school level Meghalaya to know the opinion of science teachers about the syllabus, superficially compared that syllabus with CBSE science syllabus based on NCF 2005. The findings showed that the objectives of Science teaching-learning were not stated in Meghalaya's science. MBOSE syllabus looks to be missing foremost areas whereby it fails to fulfill the criteria as identified by the NCF 2005. The syllabus of Meghalaya was only fulfilling the criteria of cognitive validity and lacking in terms of content, historical, environmental, and ethical validity.

Findings and Discussion: The researcher carefully reviewed all the above studies between the year 2000 to 2018 and found that there are more researches related to the environmental perspective then ethical followed by historical, process, content and cognitive, Whereas the least number of studies is related to cognitive validity criteria. This makes it clear that these two aspects of science education, along with all other validity, are more important for any society, it also confirms that the current trend of science textbook analysis is more concerned with environmental and ethical issues. Because these are very sensitive and globally concerned issues.

Table 1. Categorization of Studies into six Curricular Validity Proposed by NCF 2005

Category	Indian Studies		Foreign Studies		Total number of Studies
	Author and Year	Number of Studies	Author and Year	Number of Studies	
Cognitive Validity	Tron,2016	1	Erten,Şen & Yüzüak,2015	1	2
Content Validity	Deshmukh & Deshmukh, 2011; Tron ,2016; Qasim & Pandey, 2017	3	Liu &Treagust, 2013; Qadeer,2013	2	5
Process Validity	Sinha and Tripathy ,2005; Tron ,2016	2	Chiappetta & Fillman,2007; Senem ,2013; Alaghaa, Farajollahib & Shahmohammadi,2014;	3	5
Historical Validity	Tron ,2016; Sundararaman, 2018	2	Ninnes ,2000; Chiappetta & Fillman,2007; Ramnarain & Chanetsa, 2016	3	5
Environmental Validity	Rashid, 2013; Mishra, 2016; Tron ,2016	3	Ninnes ,2000; Chiappetta & Fillman,2007; Shahmohammadi, 2013; Morris, 2014; Babaei and Abdi, 2014; Erten,Şen & Yüzüak,2015; Gilavand, et al., 2016	7	10
Ethical Validity	Jangaiah,2007; Roopa Rani,2008; Choudhary,2014; Tron ,2016; Sharma, 2017; Sundararaman ,2018	6	Ninnes, 2000; Elgar,2004; Kahveci ,2010	3	9

As clear from Table 1, Tron (2016) in India analyzed the science syllabus of the Meghalaya Board concerning all the validity criteria and found that the Meghalaya syllabus only met cognitive validity criteria. It may be easier for syllabus makers to maintain this validity criterion than other criteria. Tron's main objective was the overall science education of the Meghalaya Board, so it can be said that she did not pay much attention to the detailed analysis of the textbook to examine all criteria. The researcher mentioned her study across all criteria but discussed once, although it will be counted in all categories.

In 2015 Erten, Şen & Yüzüak analyzed the textbook from the perspective of cognitive validity i.e. content should be within reach of cognitive level of the child and found many experimental activities were beyond the cognitive level of the student.
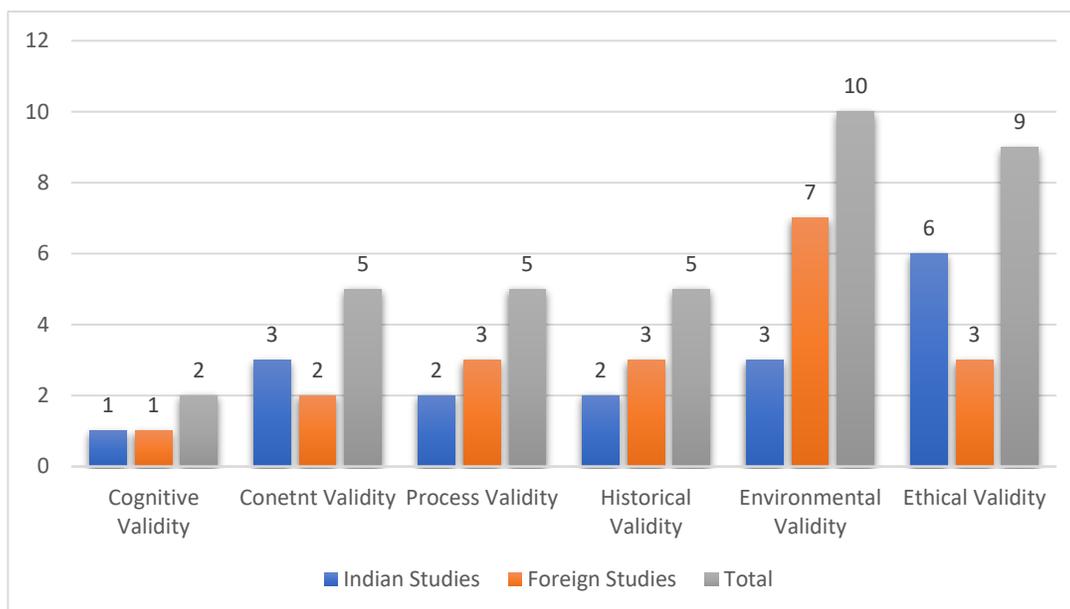
Figure 2. Categorical Representation of Studies

The Finding shows that there are 5 studies (Figure 2) related to content validity out of which two studies are related to types of diagrammatic representations (Liu &Treagust 2013; Qasim & Pandey,2017) confirmed that maximum digammas in textbooks were related to iconic type. Deshmukh & Deshmukh (2011) found that textbooks are failed to clear misconceptions of students and Qadeer (2013) found that maximum sentences lack providing a logical explanation. There are also 5 studies related to process and historical perspective. Process validity requires the curriculum must promote curiosity & creativity, generation & validation of scientific knowledge in students. Sinha and Tripathy (2005) found that textbooks are failed in allowing children to 'learning to learn. Similarly, the study of Alaghaa, Farajollahib & Shahmohammadi (2014) revealed that inadequate attention was in the textbook for nurturing mental creativity. In 2007, Chiappetta & Fillman found that the biology book of the U.S. comprises many contents related to scientific investigation for nurturing curiosity. Senem (2013) confirmed that textbooks comprise improper inclusion of science process skills. Studies related to this category showed that textbooks failed to nurture creativity. For a historical perspective textbook must enables learners to know the evolution of science, science as a social enterprise (Figure 1). Researches related to process validity confirm that some foreign authors (Ninnes, 2000; Chiappetta & Fillman,2007) wrote the science textbook with historical perspective but in contrary findings of Ramnarain & Chanetsa,2016 and Sundararaman,2018 revealed that curriculum must be improved with developing understanding related to the scientific enterprise, and evolution of science with time and negative consequences of any invention also be mentioned in the textbook so that it provides real understating of science for learners. Figure 2 clearly shows that the maximum number of researches are related to environmental and ethical validity, as these two aspects are more important for validating the science textbook of any country. In the environmental category science curriculum must promote learning of socio-scientific issues and development of certain skills for a better future. Ninnes (2000) analyzed textbooks with an environmental and ethical perspective and revealed that books of Australia and Canada present quite extensive amounts of indigenous knowledge about the natural world and also confirmed that inclusion of an adequate number of indigenous knowledges develops a positive approach to dealing with racism, ethnicity. The study of Chiappetta & Fillman (2007) and Rashid (2013) confirmed that textbook implicit inadequate STS issues. Similarly, in 2014, Morris explored the interpretation of SSI and found that issues were not explained from the societal perspective. In contrast, Mishra (2016) found an extensive range of STES issues in the NCERT textbook. Shahmohammadi (2013) confirmed that textbook promotes skill development in children to compete with the real world. On the contrary, Babaei and Abdi (2014) found that necessary social skills were dealt with superficially in natural science textbooks. In 2015, Erten, Şen & Yüzüak revealed that coursebook contents were related to everyday life. Gilavand, et al. (2016) found that books paid most attention to the management and prevention of diseases and the elements of "mental health". From an ethical perspective, a textbook must promote some values and should be free from any kind of prejudices. Roopa Rani (2008) explored IX standard science textbooks of NCERT and confirmed that chemistry and physics chapters dealt with epistemological values, while in biology, socio-cultural values were emphasized. In 2017, Sharma examined the NCERT Science textbook of 6th grade and findings showed that textbooks have many noticeable and implicit values in almost all the topics. In ethical validity criteria, there are several studies (Elgar,2004; Jangaiah 2007; Kahveci, 2010; Choudhary,2014; Sundararaman, 2018) concerning gender prejudice and findings of all confirmed that textbooks did not provide satisfactory empirical evidence to gender equity, it reflects the patriarchal system of society. The findings support that science textbooks need to be amended from the perspective of gender not only in India but around the world. It is surprising that even in this era, books are not free from gender bias.

The literature review also revealed that some foreign researchers analyzed the science textbook from more than one perspective, such as Erten, Şen & Yüzüak,2015(cognitive & environmental) Chiappetta & Fillman,2007(process, historical & environmental) and Ninnes,2000 (historical, environmental &and ethical).In India, only Tron(2016) compared the MBOSE science syllabus with the CBSE syllabus with respect to all validity criteria. Improving the science curriculum in India also promotes improvement in textbooks. Consequently, the science textbook must meet all proposed validity criteria. Therefore, all science textbooks should be necessarily analyzed to know whether they have been written keeping in mind all the validity criteria.

Overall, it can be concluded that environmental and ethical perspective of science education are more concerning areas of science textbook analysis in recent years, findings also reveals that most of the science textbooks are unable to deal with the important and necessary aspects of science education. It is therefore strongly recommended that the textbook should be written with a perspective that promotes inquiry-based

learning, understanding of the genesis of science, understanding of the natural world, understanding of issues related to science-technology-society, sensitivity towards preservation of the environment, promotes positive attitude towards prejudice related to a particular area, race and religious conviction.

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