Scholarly Research Journal for Interdisciplinary Studies
Online ISSN 2278-8808, SJIF 2024 = 8.153
https://www.srjis.com/issues_data/236
Peer Reviewed & Refereed Journal, JULY-AUG 2024, Vol- 13/84

THE HIERARCHY OF HOLISM IN PROCEDURAL KNOWLEDGE DEVELOPMENT IN SCIENCE

Sujisha E. P[1] & Prof. Dr. M. Jesa[2]

[1]*Research Scholar, Farook Training College, Kozhikode, University of Calicut, sujishaep@gmail.com*

[2] *Professor, Farook Training College, Kozhikode, University of Calicut, jesasajeev@gmail.com*

Paper Received On: 20 July 2024

Peer Reviewed On: 24 August 2024

Published On: 01 September 2024

Abstract

Twenty-first century believes in Holism and not Reductionism, be it on the concept of the Universe, the Nature, the Society or on the process of education. Quality education in 21st century demands a holistic approach with the 4C's: Communication, Collaboration, Critical Thinking and Creativity. At the higher education level, Outcome Based Education (OBE) has been clearly defined with graduate attributes, qualification descriptors, course learning outcomes and programme learning outcomes. For attaining this a bottom-up approach should be followed. Problem solving skills are graduate attribute which is holistic in nature and is usually associated with cognitive, affective and psychomotor domains. Proper acquisition of problem solving skills is associated with development of scientific temper. Problem-solving skills and scientific temper are the pre-requisites for developing procedural knowledge and the authors have designed a pool of activities based on strategies to promote these two prerequisites among secondary school students through science learning. At the critical period of secondary level education, the pre-requisites and learner attributes are to be ensured in tune with the recommendations of NEP 2020. Research to innovate effective strategies in this direction gains priority.

Key Words: *Holism, Procedural Knowledge, Strategies for scientific temper, Science Education*

Introduction

Twenty-first century believes in Holism and not Reductionism, be it on the concept of the Universe, the Nature, the Society or on the process of education. The root of holism could be traced back to 1890's when Jan Smuts coined the word with the meaning, 'a process-oriented hierarchical view of nature'. A critical analysis of the word 'process' as well as 'hierarchy'

will help bring to light the concept of 'evolution' as a 'progressive outcome'. 'Holism' when applied to the discipline of education does mean the same: process, hierarchy, progress and outcome. Revised Bloom's Taxonomy of Educational Objectives with the three domains of development (Anderson & Krathwohl, 2001), theory of multiple intelligences by Gardner and the latest approaches of cross-disciplinarity deal with the same propositions. Holism could be seen in the sequence of teaching-learning-performance and assessment in self-learning or 'study'. Quality education today demands a holistic approach with the 4C's: Communication, Collaboration, Critical Thinking and Creativity. Quality assurance process also has to be carried out by identifying the specific indication at each level of education. Here comes the added responsibility of the stakeholders as Quality Analysts. Need based contextualized planning, implementation and review should be carried out with the involvement of students, parents and the community.

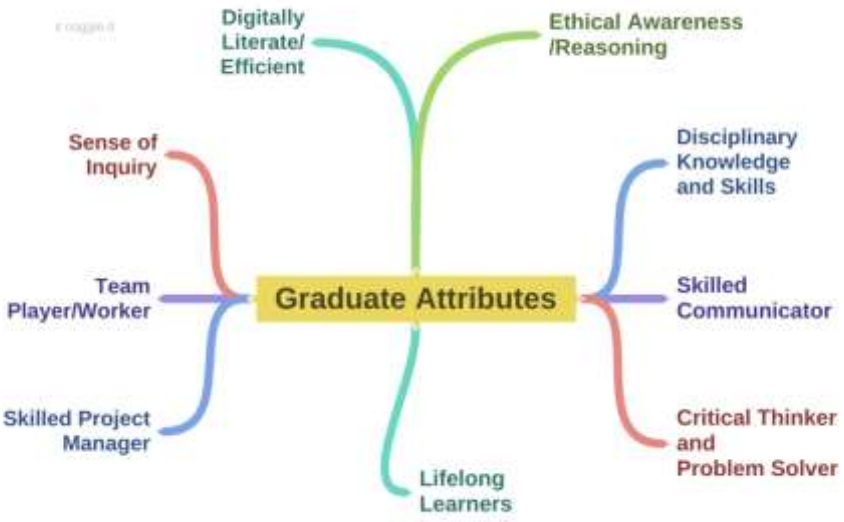
Outcome is one of the buzzwords today. Target orientation and planning at all levels will focus on outcome so that, the ventures with minimum expenses in terms of time, effort, energy and resources will reach the expected outcomes. The exponential growth rates of knowledge, demand for skilled man-power and outcome orientation have brought about rapid shifts in the curricular processes. Outcome based education, a comparatively recent approach to teaching-learning process in Indian classrooms, targets application of the resultant of classroom procedures in real life contexts. The 'holistically' developed learner alone will be successful in confronting and solving real life problem. 21st century demands efficiency in all fields of action. Indian higher education system has already set the outcomes following a multidisciplinary-holistic approach.

At the higher education level Outcome Based Education (OBE) has been clearly defined with graduate attributes, qualification descriptors, course learning outcomes and programme learning outcomes. Graduates should be able to demonstrate the acquisition of learning outcomes that are specific to disciplinary/interdisciplinary areas of learning and the capability to demonstrate generic learning outcomes. The distinct qualities, knowledge, skills, attitudes, and values that one would anticipate a university or college graduate to possess are referred to as graduate attributes. These qualities improve one's ability to learn new things, broaden their knowledge base, pick up new skills, do well in school, pursue a job, and be a good citizen. Regardless of the subject, a student who becomes a graduate must have acquired some general capacities related to life. That is, for a student who has studied

Chemistry and a student who has studied Physics, the graduate attributes to be acquired will be almost the same.

Figure 1

Graduate Attributes for Undergraduate Education (Physics & Chemistry)



Critical thinking and problem solving skills are graduate attributes which can be acquired effectively only through the proper acquisition of the graduate attributes: disciplinary knowledge and skills, sense of inquiry, skilled communication and ethical awareness/reasoning. Problem solving is holistic in nature with defined hierarchical stages and is usually associated with cognitive, affective and psychomotor domains. Problem solving skills demand too many sub-skills from secondary level students: understanding the problem, analyzing the problem, generating solutions, decision making, implementing the solution, evaluating the outcome, and reflecting and iterating. Proper acquisition of problem solving skills is associated with development of scientific temper. On the other hand, strengthening a scientific mindset fosters systematic approach to problem solving and evidence-based reasoning. Scientific temper is, "a way of life – an individual and social process of thinking and acting which uses a scientific method which may include questioning, observing reality, testing, hypothesizing, analyzing and communicating"(Nehru,1946). The components of the domain of scientific temper identified by the investigators through a review of studies and related literatures are: open mindedness and humility, healthy skepticism, universalism, freedom from prejudice or bias, objectivity, rationality, perseverance, willingness to suspend judgment without sufficient evidence, critical thinking, curiosity, spirit of inquiry, cause-effect relationship, and scientific information or literacy.

Procedural knowledge, one of the higher order thinking skills of learning science is closely associated with problem solving skills and scientific temper. That is, problem solving skills and scientific temper are the pre-requisites for developing procedural knowledge. By applying procedural knowledge, students acquire the ability to systematically solve complex problems in life. Procedural knowledge is defined as skills and algorithms, techniques and methods, as well as knowledge of the criteria used to determine and/or justify when to do what within specific domains and disciplines (Anderson & Krathwohl, 2001). In science, procedural knowledge represents commitment to evidence-based experiential learning. In this context, referring to two important documents related to aims of education seems meaningful.

1. Learning Outcomes Descriptors for higher education qualification at levels 5-10 (NHEQF, 2023):
   (i) Level 8 Bachelor's Degree (Research/Honours):
   The graduates should be able to demonstrate the acquisition of Cognitive and technical skills required to evaluate complex ideas and undertake research and investigations to generate solutions to real-life problems.
   (ii) Level 7 Bachelor's Degree:
   The graduates should be able to demonstrate the acquisition of capacity to make judgment and take decisions based on the analysis and evaluation of information for formulating responses to problems, including real-life problems.
2. The propositions of NEP 2020 on concepts and aims of education
   (i) Each stage in the hierarchy of educational structure will build on the pedagogical and curricular style of the previous stage with greater depth.
   (ii) The aim of education is not just cognitive development; rather, it is about building good character in students and turning them into holistic and well-rounded individuals with key 21st century skills through 'Panchakosha' development.
   (iii) In the three-year middle stage of education, emphasis should be placed on experiential learning in each subject and explorations of the connections between various subjects will be promoted.

When education is progressive, multidisciplinary, holistic, and flexible and the outcome is successfully living the real life, a pro-active planning of curriculum becomes the pre-requisite. "Each student has his/her own characteristics in terms of previous learning levels and experiences, life experiences, learning styles and approaches to future career-related actions" (LOCF for Undergraduate Education, 2020). If at the UG level, a learner is expected

to meet the stated graduate attributes, the process should have begun at the lower levels and a bottom-up approach should be followed. That is, the graduate attributes need to be developed hierarchically from the school level itself and the process should be age appropriate.

The authors have designed a pool of activities based on strategies to promote problem-solving skills and scientific temper among secondary school students through learning of science. Table 1 shows a few of such items.

Table 1

Sample strategies and activities to develop problem-solving skills and scientific temper

	Strategies	**Sample Activity**
Problem Solving	Initial thoughts and awareness about global problems	Solving the problems of waste management in the school through segregation at the sources.
	Continued observations on events to arrive at the scientific facts related to that event	Observe colour variations of Hydrangea flowers in different places and Identify the science behind it in relation to pH of soil.
	Critical referencing	By referring to authentic sources identify adulterants and contaminants in food products, and think about methods of adulteration and its impact on human life.
	Presenting Chemistry concepts in different contexts using hands-on activities	After cleaning the well at home, have you ever observed charcoal being placed into it? What is the purpose behind this practice? Identify similar situations in everyday life.
	Creating products with an understanding of its science	Making of Soap, Hand-wash, Sanitizer, etc. with natural raw materials.
Scientific Temper	Debates on problems related to science in daily life	Importance of Vaccination Programmes
	Critical discussions on issues and themes related to science in daily life in misleading advertisements in the media	Collect labels of Personal care products & packed food items from your surroundings and analyse them based on the norms provided by department of Legal Metrology, Government of Kerala and Food Safety and Standards Authority of India (FSSAI) to find out the harmful and toxic chemicals in them.
	Inquiry on real facts	"Bulls become angry when they see the red colour". Rationalise the statement.
	Searching for facts behind dos and don'ts	It is advisable to avoid getting wet during the first rainfall. What would you do? List out the reasons behind this.

In existing Kerala Secondary school text books, especially in Science text books, only chapter wise course learning outcomes are defined. Based on the criteria, attributes and appropriate strategies should be developed by curriculum experts while restructuring the school curriculum. It is to be ensured that the alpha generation attains the skills to solve life problems confidently and successfully, and efforts should begin from the grass root level itself to equip the future generation to reach the outcomes rooted on development of knowledge, skills, attitude, and values.

Human life in continuum, growth and development in hierarchy under system and process of education, we defined aim at holistic development. At the critical period of secondary level education, the pre-requisites and learner variables, or to be more accurate, learner attributes are to be ensured in tune with the recommendations of NEP 2020. When, 21st century skills on demand function as signpost for future education, research to innovate effective strategies in this direction gains priority. Science education should focus on the skills of problem-solving and scientific thinking to bring up a generation holistically develops to be successful in life.

References

Anderson, L.W., & Krathwohl, D.R. (Eds.). (2001). A taxonomy for learning, teaching, and assessing: A revision of bloom's taxonomy of educational objectives. New York.

Government of India & Ministry of Education. (2020). 21st Century Skills: A Handbook. https://www.education.gov.in/covid-19/Hindi/assets-hi/img/pdf/21st_Century_Skill_Handbook.pdf

Government of India & Ministry of Human Resource Development. (2020). National Education Policy 2020. https://www.education.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf

Government of India & University Grants Commission. (2023). National Higher Education Qualifications Framework (NHEQF). https://www.ugc.gov.in/pdfnews/2990035_Final-NHEQF.pdf

Nehru, J. (1946). The discovery of India. Signet Press.

SCERT. (2019). Basic Science Teacher Text for standard VIII. Thiruvananthapuram.

SCERT. (2019). Chemistry Teacher Text for standard IX. Thiruvananthapuram.

SCERT. (2019). Chemistry Teacher Text for standard X. Thiruvananthapuram.

University Grants Commission. (2020). Learning Outcomes-Based Curriculum Framework for Undergraduate Education. https://www.ugc.gov.in/e-book/locf.pdf