D.Ed Curriculum Review -2012

This is a draft position paper on Content cum Methodology of Teaching Science prepared and presented by one of the sub groups under DEd curriculum review committee. This has to be further reviewed by the core committee after taking the views of all the concerned cross sections of the stake holders. You are requested to send your opinions before 10th of February 2012

Department of State Education Research and Training

Government of Karnataka

Position Paper on Content cum Methodology of Teaching Science

TITLE: "CONTENT CUM METHODOLOGY OF TEACHING SCIENCE"

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1.1 INTRODUCTION:-

The main ambition of education in India, these days, is not only to concentrate on the advancement of science and technology but also to develop each individual as personality with total scientific attitude.

The programme of science education right from the early stages of education should concentrate on those components which add to achievement of these ambitions. The effective output of all the curricula right from the early stages of development of the child till the final stage of schooling should be able to design activities to achieve these educational objectives.

Science is a way of knowing, a method of discovering the Nature. Science education is a systematic way of helping the learner to not only to discover the Nature but to adjust to live in it without disturbing the basic structure of the Nature.

The responsibility of science curricula develops another dimension of making an individual contribute his best for maintaining the balance in Nature but also to work for sustainable development.

The discoveries made as a part of history of science, theories and laws of science related to Nature more so with environment, are to be learnt by the child during the process of schooling.

There is close relationship between the Nature of the child and also and the Nature of the Scientist in the process of understanding the world. The activity of the child is intuitive and not structured whereas the method of scientist is highly systematic and structured. In doing scientific inquiry, scientists use a variety of empirical approaches, techniques, and procedures to collect data from experience, examine and analyze the data, to construct knowledge based on the experience. The product of scientific inquiry is the body of scientific knowledge. The term science includes the knowledge of science and predominantly the method of science.

The demand of science education now is to structure such situation as to make the child interact to construct the knowledge by its own efforts like a miniature scientist, further to make the learner to acquire such skills and strategies for further independent learning. This enables the system of education to define the role of science teacher and school. This is very true at the lower rung of education like the primary education. This is the message of all the modern theories of learning and instruction. The primary education curriculum has to be developed keeping this ability of child to learn to learn.

At this stage it is appropriate to draw the best from NCF 2005 which clearly indicates the Nature of science education at school level. The responsibility of the curriculum for the present primary and higher education is to keep the following in view while framing the educational process.

1.2 Science Education: Reference (NCF2005)

Types of Validity

Good science education is true to the child, true to life and true to science. This simple observation leads to the following basic criteria of validity of a science curriculum–

(a) **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.

(b) **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.

(c) **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.

(d) **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.

(e) **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.

(f) **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.

1.3 Concerns of NCF, NCFTE-2009, RTE and other Relevant Documents

NCF Recommends science education in India has three critical issues

1. Science education is still far from achieving the goal of equity enshrined in our constitution
2. Science education in India even at its best develops competence but does not encourage inventiveness and creativity.
3. The over powering examination system is basic to most, if not all, the fundamental problems of science education in India.

Though the quality of pedagogical inputs in various teacher education courses that serve the purpose of nurturing prospective teachers depends largely on the professional competence of teacher educators in transaction the teacher education curriculum based on the ambitions of teacher education curriculum drawn on NCF 2005.

Though newer programme of teacher education have continually evolved, with substantive and curricular streamlining; it is demand by a modern developing school education programme that is compelling to look at the primary teacher science education in a new context.

The National Curriculum Framework for Teacher Education (NCFTE) aims at improving the quality of teacher education by addressing the prevalent concerns as they exist today, bring in key changes, so as to reorient teaching that emphasizes on activities, discovery and exploration of environment and surroundings.

RTE implication on science education are schooling is a legal right and science is being compulsory subject, access to quality science education is every child's right. I.e. science education should be affordable to every child and at the same time it should be made enjoyable.

As seen by us in today's universe of education, the use of ICT has caused substantial changes for learning.

- Firstly, the rich representations of information changes learners' perception and understanding of the world;
- secondly, the vast distribution and easy access of information has changed relationships between educators and learners; and
- Thirdly, the flexibility of spatial and temporal dimensions in the cyberspace changes human beings' learning life. All of these changes evidence that ICT is becoming an integral element for educational reforms and innovations in current society, and our education is reaching an age of e-education.

Undoubtedly, ICT is bringing about new opportunities for educators, because it can provide powerful support for educational innovations. However, the use of ICT in education creates ever-new challenges for teachers. They need not only to learn the skills of using ICT, but also to learn how to design innovative instructions through an integration of ICT with curriculum. Reasonably, for undergraduate students who are prospective schoolteachers,

they should be well prepared for using ICT in education. It has become a common sense that, for a pre-service teacher education programme without an integration of ICT, it could not be said to be a complete one.

In the recent past, the epistemology of learning has seen a sea change. Emphasis has now shifted towards constructivist approach of learning and one witness that learning does not involve discovering the reality, but constructing the reality. The guiding principle of the National curriculum Framework for School Education (NCF 2005) developed by NCERT, is based on the notion that learning is fundamental to a learner's physical, social, and cultural context. The NCF 2005 expects a teacher to be the facilitator of students' learning in a manner that helps them to construct knowledge and meaning which eventually utilises their individual experiences. The NCFTE 2009 developed by NCTE attempts to reorient teacher education courses. The idea is to align them with the epistemological shift envisaged in NCF 2005 and develop teachers as facilitators of learning.

1.4 How much of Constructivism at the primary

Constructivist teaching is based on constructivist learning theory. This theoretical framework holds that learning always builds upon knowledge that a student already knows; this prior knowledge is called a schema. Because all learning is filtered through pre-existing schemata, constructivists suggest that learning is more effective when a student is actively engaged in the learning process rather than attempting to receive knowledge passively. A wide variety of methods claim to be based on constructivist learning theory. Most of these methods rely on some form of guided discovery where the teacher avoids most direct instruction and attempts to lead the student through questions and activities to discover, discuss, appreciate, and verbalize the new knowledge.

Constructivist teaching methods are based on constructivist learning theory. Along with John Dewey, Jean Piaget researched childhood

development. Their theories are now encompassed in the broader movement of progressive education.

Constructivist learning theory says that all knowledge is constructed from a base of prior knowledge. Children are not a blank slate and knowledge cannot be imparted without the child making sense of it according to his or her current conceptions. Therefore children learn best when they are allowed to construct a personal understanding based on experiencing things and reflecting on those experiences. The experiential learning situations are to be drawn on the following theories related to principles.

1.5 Vygotsky's theory

1. Making meaning - the community places a central role, and the people around the student greatly affect the way he or she sees the world.
2. **Tools for cognitive development** - the type and quality of these tools (culture, language, important adults to the student) determine the pattern and rate of development.
3. **The Zone of Proximal Development** - problem solving skills of tasks can be placed into three categories:

- Those performed independently by the learner.
- Those that cannot be performed even with help
- Those that fall between the two extremes, the tasks that can be performed with help from others.

To accomplish the goals of socialization of the child as per the need of the nation and the child the context of education must be reconstructed, and the cultural assumptions, power relationships, and historical influences that undergird it must be exposed, critiqued, and, when necessary, altered and implemented.

1.6 What are the benefits of constructivism?

- Children learn more, and enjoy learning more when they are actively involved, rather than passive listeners.
- Education works best when it concentrates on thinking and understanding, rather than on rote memorization. Constructivism concentrates on learning how to think and understand.
- Constructivist learning is transferable. In constructivist classrooms, students create organizing principles that they can take with them to other learning settings.
- Constructivism gives students ownership of what they learn, since learning is based on students' questions and explorations, and often the students have a hand in designing the assessments as well.
- By grounding learning activities in an authentic, real-world context, constructivism stimulates and engages students.
- Constructivism promotes social and communication skills by creating a classroom environment that emphasizes collaboration and exchange of ideas.

1.7 Constructivist assessment

Traditionally, assessment in the classrooms is based on testing. In this style, it is important for the student to produce the correct answers. However, in constructivist teaching, the process of gaining knowledge is viewed as being just as important as the product. Thus, assessment is based not only on tests, but also on observation of the student, the student's work, and the student's points of view. Some assessment strategies include:

a) Oral discussions. The teacher presents students with a "focus" question and allows an open discussion on the topic.

b) Chart (What we **know**, what we **want** to know, what we have **learned**, **How** we know it). This technique can be used throughout the course of study for a particular topic, but is also a good assessment technique as it shows the teacher the progress of the student throughout the course of study.

c) Hands-on activities. These encourage students to manipulate their environments or a particular learning tool. Teachers can use a checklist and observation to assess student success with the particular material.

d) Pre-testing. This allows a teacher to determine what knowledge students bring to a new topic and thus will be helpful in directing the course of study.

e) The assessment of Hands-on activities, using latest non-scholastic tools.

2.1 Enumeration of specific concern

1) It is important to give children the latest knowledge of science and that it should be taught by the method of science as a product of investigation.
2) The Application of science to life is another concern.
3) Development of basic skill of science, which is part of process of science which Consisting of the following skills.

- Observation
- Data collection
- Classification
- Communication
- Hypothesizing
- Experimentation for verification
- Drawing Conclusion
- Application

This should include measurement and calculation

4) Development of Scientific Attitude

The Corresponding content area from subject of science should be selected keeping the following points in view.

1) Nature of the intellectual level of the child
2) Structure of the subject

   Facts, Concept, Principal, Laws
3) Methodology of Science

2.2 Objectives:

1. The Student teacher s structure learning situation to make pupils verbalise the names of concrete concepts.
2. Student teacher should enable the students to follow method of classification on the basis of Concrete, Iconic and Symbolic ways of learning appropriate the intellectual development.
3. Student teacher gains the ability to create opportunities for children to develop the competency to discriminate leading too multiple discrimination.
4. Should be able to develop the ability of multiple discrimination among his student the Student teacher to develop understanding of terms, concrete and defined concepts.
5. To enable the Student teacher to develop ability to classify the happening around for the understanding of environment.
6. Gain the ability of developing new concept from the learned concepts in their pupils through organisation of activities among his students.
7. Student teacher develops opportunities for the development of rules, principle and laws trough concrete experience of science by deigning laboratory activities or through activities in the environment.

8. Student teacher to develop the ability of applying the acquired knowledge and understanding into the novel situation.
9. Student teacher will be able to show that the facts, concepts and generalization are interlinked, interdependent and inter-related. Through structured experiences.
10. Student teacher develops the ability to interpret cause and effect relationships among their pupils.
11. Student teacher would be able to create joyful learning environment for enabling learning science.
12. Student teacher acquires critical thinking.
13. Student teacher gets the capability of adopting collaborative learning technique in the class.
14. Student teacher appreciates the Nature as a powerful medium for of learning science.
15. To enable the Student teacher to justify methods and Procedure for structuring learning activities based on the constructivist principles.
16. Student teacher will be able to view children as active participants in their own learning and not as mere recipient of knowledge.
17. Student teacher gets trained in organizing activity-based, learner-centered, participatory learning experience- play, projects, discussion observation, visits, integrating academic learning with productive work.
18. Broaden the view of the Student teacher s to connect school knowledge with community knowledge and life outside the school.
19. Student teacher s re-conceptualize citizenship education in terms of human rights.
20. To enable the Student teacher to use information and communication technology tools in providing learning experience in science teaching at primary level.

21. Analyze issues in Science education pertaining to equity and access, gender, special groups and ethical aspects.
22. Enable the Student teacher to reflect on the need and importance of ICT, art education, health physical education and working with the community.

Objective on the systemic changes

1. Teacher education programme need to include more research-based inquiry strategies for instruction, for Student teacher s to help build confidence in the content.
2. Teacher education programme increase the recommended percentage of hands-on activities, and reinforce that hands-on must be cohesive, integrated through the curriculum.
3. To enable the Student teacher to understand skills being developed and taught need to be connected to standards at each grade level and their mastery levels identified.
4. Develops ability for alternative assessment strategies to reinforce student.

3.1 Criticism on the existing elementary teacher education science curriculum

Presently science is taught through lecture and formal demonstration method in schools, and there are no alternative methods like constructivism, project method, laboratory method for Student teacher s in the present system. Therefore the formal training must be given to the Student teacher to operate a system and taking away project in nature**.**

Elementary teacher education science curriculum does not connects knowledge to life outside the school, given more importance to rote learning than knowledge generation, pedagogy is more text book centric rather than experimental, for assessment focus is not given on continuous and flexible

approaches, not providing opportunities to look at research studies that are available and how to use existing data for analysis, does not provide opportunities to use science to integrate with other content areas including (art, music, value education, and computer education ,etc.,), instead of just recalling factual questions curriculum should encourage use of higher level skill oriented questions including application and analysis, for assessing non-scholastic concepts there is no prescribed tools, there is no scope to reflect that science is done by doing and involve in self assessment, there is no guidance to visualize and integrate investigation into instruction, no scope for variety of assessment including use of drawing, experiments, demonstration with music or a song, tell a story, create a video, design a lab, there is disconnection between science, scientists, and the reality of the real society, to incorporate current and local issue there is no collaboration for partnership with the community at large, successful models of science teaching are not included.

4 Suggesting alternatives with justification with do ability

4.1 How should science education be at the primary level?

Lower primary stage

1. It is for joy they learn, hence joyful learning.
2. Exploration of the immediate environment through the use of sensory organs as per beginning phase of concrete operational stage of development in terms of Piaget's theory of learning and instruction.
3. Skills such as observation, classification, raising inquiry questions discrimination, measurements, and such skills as related to concrete operational development are to be given prominence.
4. The activities under classroom, lab and in the environment under Nature take the dominant place in the development of learning experiences.

5. Learning materials have to be related to the above. Skills needed for such activities are to be developed in teacher trainees in the D.Ed course.

Upper primary stage

1. The activities provided should develop the meaning of science.
2. Methodological approaches take the front seat. Structured science activities enter the field of learning.
3. Student teacher becomes a scientist who guide student learn by working with materials and events.
4. The steps of scientific method enter the process of learning giving importance to the process approach.
5. Learning science by using steps of scientific method becomes a mode of development for inculcating knowledge of science.
6. Importance is to be given for science activities involving community, problems with which community faces and protecting the balance of ecology and sustainable development.
7. The learning experience to be created for above said needs. Student teacher possess a lot of skill for organising structured activities in the class room, outside the class, during the field visits, projects and also structured laboratory activities. They are to be through selection based on the need and learning ability o the child.
8. Teachers are to be trained in the latest strategies which base on constructivism. Intellectual honesty in structuring the activity is for the factor of success.
9. The skill needed is to be blended with constructivism and method of science.
10. The speed of learning has to enhance because of the need for transferring the discovered knowledge of science and technology in a limited period of learning stage of primary education.

11. Needed vocabulary for learning is to be developed as part of integration in developing scientific literacy.

- Practical methods of science are to be used.
- Student teacher should handle the apparatus and learn to acquire the skill to present the same in the class.
- the trainee should have the opera unity to learn subject of science
- Need to include more life based information and show how concepts are used in the world; currently there is disconnection between science, scientist and reality of the real society.
- Include clear examples of what a hands-on activity is and what will be the specific outcome to be assessed. Clarify that activities are not random, but build toward a big idea or clear objective.
- The curriculum should include different types of assessments that test student mastery of higher order thinking skills.
- Assessments should be based on multiple measures of student ability, and include a variety of techniques for various learning styles and levels of readiness.
- Guidance for teachers on how to use a variety of assessment data
- Suggestions for performance assessments and other creative ways of assessing student mastery of the material, with examples of effective assessments.
- Support for teachers in meeting the needs of students with diverse cultural and educational backgrounds.
- They are to be trained in using technology in the science classroom.
- Support for a collaborative teaching model that encourages teachers to work with colleagues across subjects and grade levels.

Elementary science education must be based on the development of scientific attitude, values and training in scientific method. To inculcate

these curriculums should be developed on basis of development of these in teacher trainees. So, instead rote learning of science and pedagogy it should be based on experimental oriented training is needed on the integration of Environmental Science, Art, Music and Computer in teaching science. To teach medicinal values of vegetables it may depicted through a small skit/drama. In the same ways to develop awareness in environment and its protection it may be taught through music and songs (using Nail Kali approach).

Models of teaching such as concept attaining advanced organiser and inquiry training models must be developed and emphasized to use it. So that science teaching could be made more effective and interesting.

4.2 Broad content/methodology proposed

- Individualized constructivism.
- Social constructivism.
- Both laboratory and project experiences may use the constructivist strategies.

4.3 Precautions

- Science teacher is expected to give real experience by using real material
- Student teacher has to use the scientific principles while teaching.

5. EXECUTIVE SUMMARY

5.1 Introduction: -

Elementary school science instruction typically focuses on the more basic inquiry skills, including observing, inferring, predicting, measuring, and experimenting. Additionally, scientific inquiry refers to a specific instructional approach in which students answer research questions through data analysis.

The nature of science addresses the characteristics of scientific knowledge itself and is perhaps easier if discovered then given as information. These three essential components of scientific literacy are highly interrelated and elementary school science instruction should reflect the synergy that exists among scientific knowledge, methods of science, and the nature of science.

The experiences and the related knowledge of science should be according to intellectual level, (concrete operational stage level).

The method of science should lead to development of scientific skills.

Science at this level should contribute for learning science in the environment – so that the child prepares for living in environment without harming it.

5.2 Science Education has to contribute to the following types of Validity

a) **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.

b) **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.

c) **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.

d) **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.

e) **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.

f) **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.

5.3 Methodology processes and presentation should contribute for learning science for life and it should equip them with learning abilities for learning science by giving importance to all identified skills.

The process of learning should be based on constructivism when the child is given chance for active participation. Each child contributes for learning of other child also in a co-operative learning situation.

Teacher should be able to concentrate on each individual child and prepares himself; he is trained in structure the learning experience. Student teachers are to be trained to learn teaching skills and practice structuring of learning situation for learning and evaluation. The Student teacher has to be equipped with modern method of presentation with information

He is to be trained in concentrating on inclusive education blending other component like social attitude etc. and also should cater to children of special needs. The Student teacher s is to be train in continuous and comprehensive evaluation and made to understand that the system on which the child is

educated is to be continuously and progressively evaluated so that each child is taken as unique and the life of the child in this school is very precious and no risk is to be taken in experimenting with the Childs life but a fool proof process of education can contribute to the even development of the child. This is the context with which evaluation in school is to be seen and not for dubbing the child for what are not learnt.

As children develop, they progress through stages characterized by unique ways of understanding the world. During the sensori-motor stage, young children develop eye-hand coordination schemes and object permanence. The preoperational stage includes growth of symbolic thought, as evidenced by the increased use of language. During the concrete operational stage, children can perform basic operations such as classification and serial ordering of concrete objects. In the final stage, formal operations, students develop the ability to think abstractly and metacognitively, as well as reason hypothetically.

In general, the knowledge of Piaget's stages helps the teacher understand the cognitive development of the child as the teacher plans stage-appropriate activities to keep students active.

The first step in implementing a skills-based approach to science instruction begins by carefully defining what we would like children to be able to do. Discovery Works organizes science skills into three separate groups: Process Skills, Reasoning Skills, and Critical Thinking Skills. These groups correspond to three distinct types of cognitive skills.

Process skills are used to gather information about the world.

Reasoning skills help children make sense of the information they gather by fostering an open mind, curiosity, logic, and a data-based approach to understanding the world.

Critical thinking skills require students to apply information in new situations and in solving problems.

Recognizing the importance of developing science skills in elementary school and carefully defining and organizing those skills are necessary, but not sufficient, for implementing change. A major stumbling block is our focus on teaching science skills in isolation from their real world applications. A wide body of research suggests that learning to solve problems in a variety of contexts fosters the development of a general problem-solving ability that can be transferred to new contexts. Without practice in applying science skills in real problem-solving situations, transfer is unlikely to happen.

There is a need to train teachers in additional competencies regarding environment education.

The teacher training curricula should integrate environment education with the methodology component of all disciplines, since environment is a part of all areas of study

Weight age could be assigned in the practical component of the content – cum methodology courses of all disciplines, for environment education. Appropriate training strategies need to be devised considering the constraints in which the teacher training system.

It is agreed, that teachers are potential change agents and are capable of generating a workforce of enlightened, skilled and motivated learners. They can empower the citizens with the ability attitude and values to protect the environment using formal and non formal channels of education. It is essential that teachers themselves need to be trained and equipped with the requisite knowledge skills and values to effect such a change.

5.4 Recommendations

Science is more than a body of knowledge and way of developing and validating that knowledge.

Science is a social activity that reflects human values, including curiosity, creativity, integrity, and skepticism.

Developing scientific literacy requires meaningful, engaging transaction that integrates the knowledge of science, the methods of science, and the nature of science.

Scientific inquiry as both content and as a process for learning provides opportunities for students to develop inquiry skills, use critical thinking, and deepen their understanding of science content. Further, research strongly supports our experience that students enjoy the challenges of scientific inquiry when given appropriate support, and that they are enthusiastic participants in learning about the nature of science and how we know what we know. Teaching the nature of science and inquiry encourages students to develop scientific habits of mind that will enable them to be effective decision-makers beyond the classroom.

Student teacher s in science courses should be given ample opportunities to develop a sound understanding of science, the Nature of Science, and the interrelationships among science, technology, society and the environment.

Practicing science, teachers are encouraged to engage in authentic science experiences (e.g., collaborative community partnerships) and professional learning experiences (e.g., conferences), in order to develop a deeper understanding of how science is done, and to increase and/or update their understanding of the Nature of Science. Student teacher s should be given opportunities to learn about the Nature of Science along with science curriculum, assessment, and pedagogy.

Research suggests that constructivist teaching is an effective way to teach. It encourages active and meaningful learning and promotes responsibility and autonomy. Because constructivist teaching is beneficial in achieving desirable educational goals for students, it is important for teachers to grow professionally towards a constructivist practice.

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