DESIGNING ICT–ICON MODEL INTEGRATION BASED SCIENCE PEDAGOGY: A COURSE CONTENT PROPOSAL FOR SCIENCE TEACHER EDUCATION AT SECONDARY LEVEL

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ABSTRACT

Science is a systematic and broad field of knowledge that experiments and explores the facts relevant to living and nonliving which has greater value due to its efficient uses in day to day life practices. It has technological tools and principles that have the ability to bring out the prosperity for the society. Hence, it has attended a significant and compulsory position in school education. In this context, it is really crucial to prepare competent science teachers for the education system who can efficiently achieve the goals of science education in terms of inculcating relevant level of scientific knowledge, understanding, skills, ability, attitude, temper, interest among the learner. One of the strategies to achieve these objectives is to adopt adequate science pedagogy. In most of the secondary science teacher education curriculum, including Odisha state, it is found that though theoretical content related to constructivism, 5 E model, ICON model, ICT is provided practical activities for designing science pedagogy integrating ICT and ICON model is not emphasized. Hence, a practical based novice course content for merging ICT-ICON model to design relevant science pedagogy is proposed in the current paper to make science teacher and teacher educators preparation more effectual. The paper intended to design aim, objectives, course content, transactional strategies, evaluation on ICT–ICON model integration based science pedagogy.

KEYWORDS: *ICT–ICON Model, Science Pedagogy, Science Teacher, Secondary Level*

INTRODUCTION

Science is an active, energetic, broad field of knowledge and experience that made people to acquire suitable skills and competencies to adopt the changing world and to change the world in a favourable direction. Science is a systematic and broad field of knowledge that experiments and explores the facts relevant to living and nonliving which has greater value due to its efficient uses in day to day life practices Not only the individual but also the whole nation and human civilization have been taking advantages of Science for personal and collective growth and development. Now-a–days, Science in school education has attained a significant and compulsory place because of its wide application in daily life as well as for providing vast scope at vocational field. Teaching Science is one of the challenging tasks undertaken by the science teacher. With this respect the role of science teacher in the society is crucial as they are having the great responsibility to teach science in an effective way, so that the nation can get competent man power in the field of Science and Technology. They need to utilize effective and innovative pedagogy in science education. In this context, it is really crucial to prepare competent science teachers for the education system who can efficiently achieves the goals of science education in terms of

developing relevant level of scientific knowledge, understanding, skills, ability, attitude, temper, interest among the learner. The entry of ICT, mass media and the satellite television into the field of education has added to the roles of the teacher. Participation of several people in creating learning settings demands newer competencies in teacher to take their help meaningfully.

Rationale

The teacher education Programmes need to provide for diversification in getting specialized for different kinds of learning settings (National Focus Group on Teacher Education for Curriculum Renewal 2009). Teacher must organize learner-centred, activity-based, participatory learning experiences – play, projects, discussion, dialogue, observation, visits and learn to reflect on their own practice (NCFTE 2009). Chin-Chung Tsai (2001) emphasized science teaching through the Interpretation construction design model and its instruction to internet based activities. One of the strategies to achieve these objectives is to adopt adequate science pedagogy. ICT–Pedagogy integration emerged as a novel strategy to teacher education. Teacher must know how to use these tools effectively and efficiently, teachers need visions of the technologies' potential, opportunities to apply them, training and just-in-time support, any time to experiment. Only then can teachers be informed and confident in their use of new technologies. Teaching is becoming one of the most challenging professions in our society where knowledge is expanding rapidly and much of it is available to students as well as teachers at the same time. As new concepts of learning have evolved, teachers are expected to facilitate learning and make it meaningful to individual learners rather than just to provide knowledge and skills. Modern developments of innovative technologies have provided new possibilities to teaching professions, but at the same time have placed more demands on teachers to learn how to use these new technologies in their teaching. These challenges ask teachers to continuously retrain themselves and acquire new knowledge and skills while maintaining their jobs. Research indicates that ICT can change the way teachers teach and that it is especially useful in supporting more student-centered approaches to instruction and in developing the higher order skills and promoting collaborative activities. ICT can be used as a core or a complementary means to the teacher training process. Using ICT as a part of training methods and promote teachers' ICT–pedagogy integration in the classroom by demonstrating examples and allowing discussions among teachers throughout the whole training process is a method. Participants of the training are asked to actually use ICT to learn about ICT skills and develop ICT-integrated pedagogies. These training strategies seem to be supported by previous research that argues that teachers are likely to benefit by actively experiencing ICT skills as a learner. Thus, many researches support the training on integration of ICT and pedagogy strategy for effective teacher education. To remove the difficulties and obstacles in science teacher education, and make it more advanced, teacher educator can implement training on skills and strategies that can be adopted by science teacher while integrating ICT and bioscience pedagogy in genuine classroom situation. To make appropriate use of ICT for Science teacher education it is important for the teacher education system to give adequate basic knowledge about tools and techniques in ICT. After that students should be trained for applying their ICT knowledge, understanding and skills in science pedagogy. As compared to traditional pedagogy, pedagogy integrated with ICT has greater significance as it creates more dynamic teaching learning situation. This combined form is more active, collaborative, creative, integrative, and evaluative than the traditional pedagogy. After providing training on the theoretical and practical knowledge of ICT and pedagogy it would be easy for the science teacher to integrate ICT and science Pedagogy. But it could not be fruitful unless they identify the tools, strategies, steps and process of combining both. In addition to that, they need to identify the means and tools that can help the teacher to combine ICT and science Pedagogy. In most of the

secondary science teacher education curriculum including Odisha state it is found that though theoretical content related to constructivism, 5 E model, ICON model, ICT is provided, practical activities for designing science pedagogy integrating ICT and ICON model is not emphasized. Hence, a practical based novice course content for merging ICT–ICON model to design relevant science pedagogy is proposed in the current paper to make science teacher and teacher educators preparation more proficient.

ICTs stand for information and communication technologies and are defined, for the purposes of this primer, as a "diverse set of technological tools and resources used to communicate, and to create, disseminate, store, and manage information." These technologies include computers, the Internet, broadcasting technologies (radio and television), and telephony. ICT is an umbrella term that includes any communication device or application, encompassing radio, television, cellular phones, smart phone, Tab, computer and network hardware and software, satellite systems and so on, as well as the various services and applications associated with them, such as videoconferencing and distance learning. Information and communication technologies in education deal with the use of Information and Communication Technologies (ICTs) within educational technology. ICT covers any product that will store, retrieve, manipulate, transmit or receive information electronically in a digital form, for example, personal computers, digital television, email. So, ICT is concerned with the storage, retrieval, manipulation, transmission or receipt of digital data. Importantly, it is also concerned with the way these different uses can work with each other. The internet offers specific collaboration tools that are useful for the communication in learning communities such as email, discussion groups, chat, screen sharing, audio conferencing, video conferencing.

Black and McClintock (1995) framed an interpretation construction design model. This model is based on constructivist approach to learn. It emphasized that combining several other instructional design theories, this model prescribes instruction based on observations and constructing information well. Interpretations (understandings) based on observations and background contextual information. This model is based on two principles such as (i) study is the best description of learning process and (ii) learning should involve authentic tasks, activities and situations. According to the ICON model of learning, construction of knowledge is the actual study and study occurs best in the environment that has been established for learning are the conditions to learn. The facilitator's role is only to create a study support environment. This model has seven steps such as observation, interpretation construction, contextualization, cognitive apprenticeship, collaboration, multiple interpretation, and multiple manifestation. Students can assess by performing authentic tasks in authentic environments and situations.

It is beyond doubt to say that ICON model is one of the effective strategies to carry out constructivist learning in a science classroom that promotes collaborative learning environment. Using ICT mediated tools and techniques in ICON model based science pedagogy can facilitate teaching learning process at secondary level. In this concern it is essential to explore what should be the course component of ICT–ICON model based course structure relevant for science pedagogy at secondary level? How to integrate ICON model based constructivist learning using various ICT based tools and techniques in science pedagogy?

OBJECTIVES OF THE STUDY

The objective of the study is to

Design ICT–ICON model based course structure relevant for science pedagogy at secondary level.
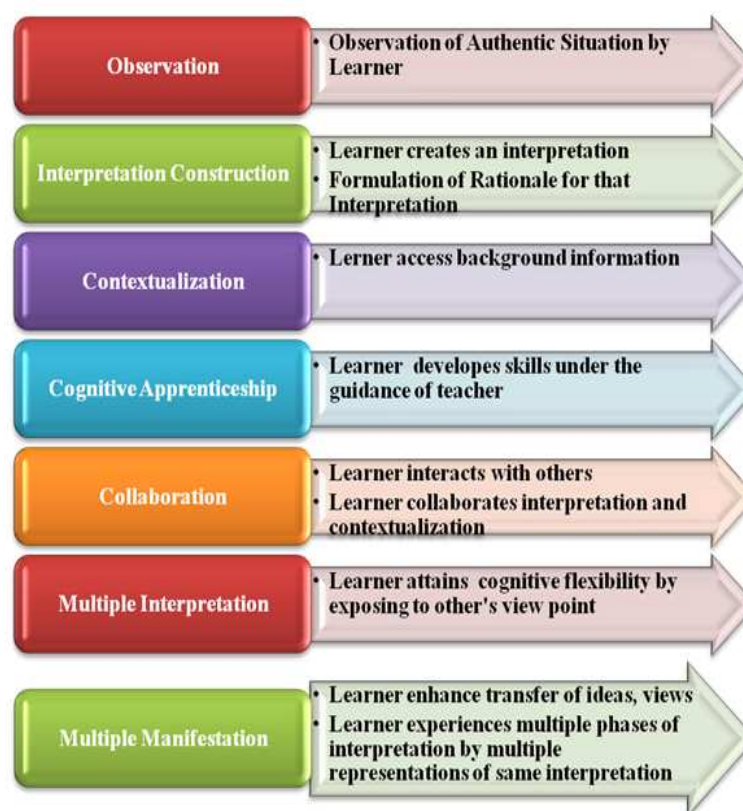
Figure 1: Steps of ICON Model.

METHODOLOGY

Both qualitative and quantitative research methodologies were used to conduct the research in this context. Qualitative document analysis methodology has been followed to conduct the study. B.Ed. syllabus of SCERT, Odisha, NCF 2005 and NCFTE 2009 documents were used in document analysis method.

Descriptive survey method has been followed in the study where science teacher educators were interviewed regarding ICT–ICON model based course structure relevant for science pedagogy at secondary level.

Sample

Twenty science teacher educators working in various secondary teacher education organisations of Odisha were selected as sample for the study using purposive sampling technique.

Tool

Self developed structured interview schedule has been utilised for the collection of data with respect to ICT–ICON model based course structure relevant for science pedagogy at secondary level. The interview schedule contains 10 open ended questions on the basis of needs, aims, objectives, course content, ICT based tools, curriculum transaction strategies, assessment and evaluation of course content as well as suggestions for creating ICT–ICON model based course structure relevant for science pedagogy at secondary level.

RESULTS AND DISCUSSIONS

Data collected through qualitative document analysis process was analyzed using inductive and deductive method whereas responses collected from 20 science teacher educators of state through interview schedule were analysed quantitatively in terms of percentage. On the basis of maximum percentage of responses to each category of interview schedule course content with respect to ICT-ICON model based science pedagogy for secondary level has been prepared.

Table 1: Responses of Science Teacher Educators with Respect to
Preparation of ICT-ICON Model based Science Pedagogy

Serial No.	Criteria of Interview	Percentage of Response
1	Title of Course Content	80%
2	Target Group	75%
3	Aims	65%
4	Objectives	60%
5	Concepts of Course content	85%
6	Tools and techniques of ICT	70%
7	Transactional strategies	75%
8	Assessment and Evaluation	80%
9	Suggestions	90%

Details of ICT-ICON Model based Course Content for Science Teachers and Teacher Educators

On the basis of science teacher educators one course content on integrated model of ICT-ICON has been prepared referring various documents such as NCF 2005, NCFTE-2009 and state B.Ed. syllabus prepared by TE& SCERT, Odisha (2015). The details of course content for science teachers and teacher educators can be specified as follows:

- **Course content Title:** Designing ICT–ICON Model based Science Pedagogy
- **Target Group:** Science teachers, Science teacher educators
- **Aim:** To make science learning easy, joyful, effective at school level.
- **Objectives:** After going through this course student teachers and teacher educators will be able to

  - Define the ICT–ICON model based science pedagogy.
  - Differentiate ICT approach and ICON model approach to teach science.
  - Integrate tools of ICT and steps of ICON model for effective science teaching.
  - Design ICT–ICON based modules to teach science.
  - Frame lesson plans on ICT–ICON based science pedagogy.
  - Make science learning interesting and resourceful and joyful.
  - Create science learning constructivist and activity based.

Concept of Course Content

Concepts of Course content for ICT–ICON model based science pedagogy are:

- Need, importance of ICT–ICON model based science pedagogy
- Meaning, nature and characteristics of Integrated ICT–ICON model based science pedagogy
- Types of tools and techniques for integrated ICT–ICON model based science pedagogy

- Lesson planning, activities, resources and role of teachers in ICT–ICON model based science pedagogy
- Merits and challenges of ICT–ICON model based science pedagogy

Tools and Techniques to Integrate in ICT–ICON Model based Science Pedagogy

- *Movie:* Using movies related to evolution, Biotechnology, cloning, agriculture, microbiology, physiology, astronomy, chemical science inside classroom combined with science pedagogy. Students can observe the activities of scientists, themes of science in the movie and build some understanding in concerned science concepts.

- *Virtual Field trips*: Unreal, internet assisted visit to plant and animal cell, different physiological system, forest, evolution, journey to the centre of atom, planet system can be organized.

- *Animation*: Using cartoons and animation related to different branches science and related to concepts like pollution, different physical, chemical, biological, practical experiments.

- *Internet Learning Resources* for teaching learning of various concepts of science like magnetism, electricity, bioscience, chemicals, atoms and their structure etc.

- *Software Packages:* Computer assisted learning packages on science context for teaching equation, solving difficult problems in science, biological context.

- *Simulations* packages to make learner simulated to learn different concepts through ICT.

- *Teleconferencing techniques* to make students interlinked with other subject experts for clearing their doubts.

- *Online Games* for learning concepts like evolution, pollution and other concepts in bioscience, knowing the formulae of chemicals, solving problems in physics.

- *Power Point Presentation* for systematic presentation on science concepts systematically.

- *Radio, Television* programmes on wild life, animal and plants, engineering concepts, mechanics, chemistry.

- *Video* Visualization and graphical representation of the Abstract Concept like electromagnetism, anatomy, physiology, chemistry.

- *Electronically Journal, Report, References* on teaching and learning in science.

- *Saved MS Word and MS Excel Files* related to science teaching.

- *Online classroom* can be utilized for teaching learning beyond the classroom.

- *E mail, Video conferencing and Audio conferencing* links the learner with science resource person and community.

Transactional Strategies for using Tools of ICT in ICON Science Pedagogy

The teachers should be provided with training on strategies, steps, precautions to integrate tools of ICT with ICON science pedagogy in a systematic manner. The science teacher can be oriented for implementing following strategies to integrate ICT and ICON model in Science pedagogy.

Planning and Preparation for Integration

Science teachers need to be aware of proper way of planning for the integrating ICT and ICON science pedagogy. For this purpose, the teacher educator can teach students about how to plan and prepare for integration process which include selecting the topic, identifying the teaching point and instructional objectives selecting the tool from ICT, designing the lesson as well as activity, constructing activity form containing tasks for students for performing different activities, planning for organizing the physical (equipment) and human resources (staff, helper, students, authority), evaluation questions etc.

Formulating Objectives

The designed lesson must contain instructional objectives related to the cognitive, affective, psychomotor dimension. Teacher must set objectives for making student able to know, understand, apply and develop skills in concerned scientific context at the end of ICON lesson combined with ICT.

Implementing the Constructive Approach and Method of Teaching

Selecting and using constructivist approaches through ICON model strategies play a very significant role for presenting the ICT mediated science content to the students. The teacher educator must give instruction to the student teacher on how to

Instructional Methods

The following instructional methods can be utilized to implement this course content. Those are as follows:

- Lectures
- Seminar
- Conference, Discussion, Debate, co curricular activities
- Conducting Case Studies
- Projects
- Orientation course for in-service teachers
- Organizing Work shops
- Conducting Research Activities
- Showing movies, documentaries, Power point presentation
- Supply of books, magazines
- Continuous illustration and frequent examples of lesson plan
- Creating adequate attitude, confidence, behaviour, act of teacher through continuous inspiration
- Frequent orientation by college, university as well as guest lecturers/professors, ICT experts
- Training on use of Educational Technology
- Creation of favourable attitude, views, appreciation and interest the teachers
- Commencement of practice teaching class relevant to development of skills to impart ICT-ICON model in science teaching

Organization and Management

It is the responsibility of the science teacher educator to instruct the student teacher about how to organize physical and human resources for effective teaching learning through ICT. Training on handling and administrating ICT equipments, operating computer, software, T.V., CD, projector, managing students in ICT laboratory, probing question managing student's response, organizing discussion among students, clearing doubts and queries of students should be provided. The teacher educator should instruct student teacher how to make science students arrive at the conclusion and discover as well as construct knowledge, solve problems in a systematic, logical way and thereby provide meaningful learning experience to the students.

Evaluation in ICT–ICON Model based Lesson Plan

Teacher educator must suggest students on framing evaluation question that would be asked at the end of ICT–ICON Model mediated science lesson. Student teacher must able to construct questions based on the knowledge, understanding, application and skill objectives appropriate for ICT mediated science teaching.

Assessment and Evaluation of Course Content

Frequent evaluation of each student teacher's attitude, view, and behaviour towards ICT–ICON model must be done. Both by formative, summative, diagnostic way of evaluation can be done to assess students. Designing remedial activities to enhance ICT–ICON model based science pedagogy must be organized.

     Evaluation strategy may include

- Assigning Lesson Plan
- Project work
- Sessional work
- School based activities
- Practical work of teaching
- Viva
- Written test
- Exhibiting modules of teaching.

SUGGESTIONS

Teacher educator must train teachers how to use these tools to integrate ICT and ICON model based pedagogy in a systematic manner in classroom situation by teaching following principles of activity, collaboration, creativity, integration, evaluation approaches.

- Activity should be determined by the learner instead of teacher.
- Shifting rigid classroom to flexible joyful environment.
- Small group activities instead of whole class instruction.
- Pace must be determined by the learner rather than teacher.
- Working in team must be encouraged instead of individual.

- Shift from homologous group to heterogeneous group.

- Creation of cooperative environment supporting each other rather than every one for himself/herself.

- Reproductive learning to productive learning.

- Providing encouragement on finding solution to new problem instead of applying known solution to problem.

- Integrating theory and practice.

- Emphasizing relation within science subject like bioscience, chemistry, physics, and inter relation with other subjects like mathematics, geography, etc.

- Creating thematic environment rather than disciplined based.

- Employing teams of teachers.

- Shift from teacher directed to student directed evaluation.

- Giving more emphasis on Diagnostic evaluation than summative evaluation.

CONCLUSIONS

Science is an organized and ordered way of investigating and understanding the world which is essentially practical in nature. Though this approach of integration of ICT–ICON pedagogy seems unique and interesting it is not free from different problems and hurdles such as absence of competent science teacher educator who have sound knowledge both in the field of ICT and science Education, non availability of ICT laboratory equipped with computer, internet connection, software, staffs. In addition to this, many teacher education institutions are lacking adequate course content, syllabus, curriculum, learning resources on integrated ICT–ICON pedagogy approach in science teacher education. To solve these problems the Teacher Education system has to plan, organize and implement several pre- service as well as in-service programmes in association with competent human, physical, financial resources related to ICT mediated science Teacher Education to get significant success in preparing effective, competent science Teachers for the country. However, Science learning can be made more interesting, investigative, and fruitful by merging both ICT and ICON model. In this regard it can be suggested that science teachers of secondary schools must utilize ICON model merged with ICT.

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