Introduction of Didactic Approach in teaching –learning Mathematics and Science using Information and communication technology (ICT) as visual tool

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Abstract

Didactic approach of teaching –learning abstract concepts in Mathematics and science becomes more meaningful and effective if it is integrated with information and communication technology (ICT) as it stimulates visual learning. Visual learning is more powerful due to the fact that individual’s brain responds to stimulus provided by the environment enriched with information. When such information is perceived it triggers neuronal network in the brain so that the individual voluntarily or involuntarily responds to the stimulus to an appreciated level. ICT enriched content enables learners to carry out self imposed learning as it facilitates the students to carry out reinforced learning outside their class rooms as human brain is accustomed to repetition. The paper presents ICT enriched teaching –learning model in Chemistry subject to make learning simpler. It targets on explaining how to understand balancing chemical equations using ICT enriched teaching –learning model designed by the author and its effect on visual learners.

KEYWORDS: Visual learners, Stimulus-response, Information and communication technology, and teaching-learning model.

Introduction

Visual learners: Visual learners are those who have strong visualizing skills, they could often see the information written or drawn and care capable of making movies in their minds of the information they are reading.

Stimulus- response: Stimulus is a sensory response experienced by an individual resulting in strong response complimentary in nature.

Information and Communication Technology (ICT): Is media through which visual learning is facilitated in terms of stimulus – response mechanism using a suitable teaching-learning model.

Visual learning is an effective teaching learning style which involves ideas, concepts, data and other information associated with images and techniques. It is one of the three basic types of learning styles that also includes kinesthetic and auditory learning. Integration of information technology in visual learning promotes critical thinking that is
linking verbal and visual information so that learners make connections, understand relationships and recall related details by means of three basic steps as follows.

**Retention**

According to research, learners remember the information in a better way if represented and learned both verbally and visually.

**Comprehension**

Learners comprehend new ideas in a meaningful manner when they are connected to prior knowledge.

**Organization**

Learners’ use diagrams to display large chunk of information in ways that are easy to understand and help to reveal relationships and patterns.

ICT enabled Visual learning helps learners to build data literacy as they explore information in a dynamic inquiry process, using tables and plots to visually investigate, manipulate, analyze and formulate questions as well as discover meaning from the visual representation as shown below. According to figure 1 visual learners perceives information through visual sense and analyses the perceived information using memletic styles such as:  a) Associating new knowledge with the knowledge existing in the memory, b) Visualizing that creating in individual’s own mind eyes sensory abilities, experiences, ideas, to strengthen existing and acquiring new skills, c) Verbalizing that is rehearsing one’s own self-talk to align the set learning objectives, d) Aural that is listening recorded lectures, e) physical that is using one’s own body, f) social that is promoting group learning, g) Solitary that is promoting self-study and h) logical that is promoting meaningful learning.
Richard Felder and Linda Silverman (2002) suggested visual learning enables the learners to balance learning process by developing ability to take in new information and make sense of it quickly, accurately, and effectively. According to skinner (1958) ICT enabled visual learning imposes the presentation of a reinforcing stimulus as one of the basic principles of operant conditioning. In addition to operant conditioning principles, Seymour Papert (1980) suggested constructivist approach in which knowledge is structured and organized so that learner’s own perceptions of prior experiences into knowledge structure. The importance of how the learner relates new experiences to existing knowledge becomes paramount. Hoogeveen (1995) research suggests the effectiveness of multimedia an integral approach of ICT paradigm in teaching and learning is believed to lead to the following psychological responses:

- a high level of stimulation of the senses, particularly auditory and visual perception systems
- a high level of involvement, attention and concentration
- emotional arousal making the activity fun
- strong recognition effects, using mental reference models

Carbo, 1986; Campbell and Campbell, 1999) suggested that, when learners are able to use their own particular style of learning and processing information, their motivation,
initiative and results improve. Interactive technologies encourage active learning and, with the increased popularity of computers, today’s students are learning with technology, as opposed to learning about technology. (Schweizer, 1999; Nelson, 2001) explained that teachers could provide powerful learning opportunities through ICT as students become responsible for their own learning and are active learners defining their learning needs, finding information, assessing its value, building on their own knowledge base and communicating their discoveries. These online activities need to be carefully designed, giving thought to the different learning styles of students and the way in which students learn. In the information age, the implications of a move from teacher-centered to learner-centered education are that it is important for students to be able to analyze and synthesize enormous amounts of information, thus determining what should be learned, how it will be learned, and when it will be learned. The rapid development of ICT, particularly electronic communications and easy access to information through the Internet and email, is now an undeniable fact of contemporary life and one that is inextricably linked with modern education. As students and teachers begin to use ICT in classrooms, its use has the potential to lead to changes in the role of the teacher and the school. The teacher’s role, as described by Scheffler and Logan (1999), should be to work in collaboration with students as knowledge is applied to authentic situations. Teaching no longer centres around the transfer of content from teacher to student. Instead, learning comes from student inquiry, critical thinking and problem solving based on information accessed from a variety of sources. Godfrey (2001) stated that teachers should be well trained in ICT to enable them to develop programs pertaining to curriculum and become confident, critical and acquire multiple skills, both, in the use of technology and in task design. Therefore teachers need, not only possess the ICT skills, but also the models of best practice and knowledge to support learning. They need to understand the rationale for integrating ICT into learning environments and interpreting curriculum documents to make decisions about designing, delivering, managing and evaluating instruction. Von Glasersfeld (1989) emphasized that learners construct their own understanding and that they do not simply mirror and reflect what they read. Learners look for meaning and will try to find regularity and order in the events of the world even in the absence of full or complete information. The work of Glasersfeld was further supported by Vygotsky (1978), who suggested that when learners by experiencing the successful completion of challenging information within close proximity to their curriculum or slightly above, their current level, gain confidence and motivation to embark on more complex challenges. This kind of didactic approach (Wertsch 1997) enables learners to shape the knowledge enabling the learner to create, to discover and to attain truth in the learning process. The present paper explains a developed model lesson plan integrating ICT in accordance to didactic approach.
ICT enriched teaching –learning model

The teaching learning model designed to explain balancing of Chemical equations

Figure 2

Figure 2 explains the importance of balancing chemical equations in Chemistry. The teacher explains that chemical equations represent a chemical reaction using chemical formulae and symbols and stresses that it always follows the Law of conservation of mass. The important aspect of a balanced chemical equation is highlighted by the teacher saying that there would always be a relationship between reactants and products in terms of masses or volumes of gaseous reactants and products.
The figure 3 is designed to explain the method of balancing the chemical equation by didactic approach.

The pyramid represents the various steps to be followed in balancing a chemical reaction.
This model could be made interactive enabling the learner to balance the chemical equations given as an exercise to complete. Such visual models have a profound effect on the nervous system and enable to get motivated to learn abstract concepts.

**Sample**

100 Students in the age group 14 to 15 years (both boys and girls) were selected for the study. Further the sample were divided into experimental and control groups. To the experimental group ICT is implemented in the classroom to teach balancing of chemical equations for six weeks. A pre and post test was conducted to evaluate the effectiveness of ICT teaching –learning model and achievement test scores in Chemistry.

**Objectives of the study**

To find the effectiveness of ICT integrated teaching-learning model with didactic approach.

To find the impact of ICT integrated teaching-learning model on visual learners.

**Research questions**

What is the impact of ICT integrated teaching-learning model with didactic approach on visual learners?

What is the influence of ICT integrated interactive self learning model on visual learners?

**Research tool**

Evaluation of ICT as visual tool questionnaire was prepared consisting of 25 statements was distributed to the students to find out the effectiveness of ICT as visual tool. Each statement consists of five options a) Totally agree, b) agree, c) neither agree nor disagree, d) totally disagree and e) disagree. Reliability of the questionnaire was calculated by test and re test method and found to be 0.756.

**Methodology**

The present study focuses the effectiveness of ICT integrated teaching-learning model with didactic approach on visual learners by proposing an interactive teaching –learning model explaining the balancing of chemical equations. Balancing chemical equations is one of abstract concepts in Chemistry as most of the learners ignore learning the as they find it uninteresting. Therefore, in the present study, an effort has been attempted to present the concept by the integration ICT. The author designed the presentation on balancing of chemical equations using a self learning interactive Microsoft power point. The learners in the age group 14 -15 years were stimulated using the PowerPoint presentation consisting of five slides, slide 1 shows the information regarding the chemical equation in the word format to be balanced. The learners read the chemical equation in the word format and attempt to write it using chemical formulae and symbols.
The student attempts to write the chemical formulae and symbols in the space provided to them till they get it correct. Then they go to slide 2 consisting of the instructions in step 2 to count the number of atoms in the left and right hand side of the equation. Once they get correct number of atoms on left and right hand side of the equation they go to slide 3, slide showing the instructions in step 3 that both the left and right side of the equation to be multiplied with suitable numerals to equalize the number of atoms in the left and right hand side the same. Once the students attempt equalizing the left and right side of the equation they go to slide 4 showing the instruction to check the number of atoms on both sides the same. The students count the number of atoms on the left hand side of the equation and also right hand side of the equation separately, once they attempt both the sides the same they go to slide 5 showing the balanced chemical equation. A pre test was conducted in chemistry on balancing of chemical equations without the implementation of ICT as well as evaluation of ICT as visual tool questionnaire was distributed to students. A Self-learning power point presentation was used to teach the same topic for six weeks and a post test was conducted in chemistry to find out whether there is improvement in achievement test score. By visualizing the presentation they would get first hand information about balancing chemical equations. The concept is reinforced by self imposed learning material on balancing chemical equations. By repetitive learning the learner acquires an imprint on the brain and enjoys the process of learning. Several brain research studies have shown that recognition provoked differentially localized increases in the posterior hippocampus, and prefrontal cortex. Learning and recognition of the patterns thus activated identical visual regions, but different in extra visual regions. It was found that the hippocampus is active in recognition. Thus, visual learning and recognition of the same patterns make use of identical visual areas, whereas retrieval of this material from the storage sites activates only a subset of the visual areas. The extra visual networks mediating storage, retrieval, and recognition differ, indicating that the ways by which the brain accesses the storage sites are different.

Table 1: To show the significant differences in pre- and post- test scores with regard to evaluation of ICT used in the study of the sample.

<table>
<thead>
<tr>
<th>Group</th>
<th>Gender</th>
<th>Test type</th>
<th>Mean</th>
<th>S.D</th>
<th>“t”</th>
<th>L.S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>Boys</td>
<td>Pre test</td>
<td>100.82</td>
<td>15.47</td>
<td>3.43**</td>
<td>0.01</td>
</tr>
<tr>
<td>group</td>
<td></td>
<td>Post test</td>
<td>106.80</td>
<td>8.02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td>Pre test</td>
<td>112.99</td>
<td>9.43</td>
<td></td>
<td>8.173***</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>Post test</td>
<td>122.81</td>
<td>6.118</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys</td>
<td>Pre test</td>
<td>107.90</td>
<td>15.63</td>
<td></td>
<td>1.12</td>
<td>N.S</td>
</tr>
<tr>
<td></td>
<td>Post test</td>
<td>107.97</td>
<td>10.09</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Control group

<table>
<thead>
<tr>
<th>Gender</th>
<th>Pre test</th>
<th>Post test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Girls</td>
<td>109.88</td>
<td>112.37</td>
</tr>
<tr>
<td></td>
<td>10.46</td>
<td>8.47</td>
</tr>
</tbody>
</table>

*P < 0.05 , **P < 0.01 , ***P< 0.001, N.S= not significant

The “t” values of the experimental group found to be significant indicating that implementing ICT as a visual tool in teaching learning process helps in understanding the concept by promoting meaningful learning.

Table 2: To show the relationship between achievement test in Chemistry and evaluation of ICT as Visual tool

<table>
<thead>
<tr>
<th>Group</th>
<th>Gender</th>
<th>Test type</th>
<th>N</th>
<th>“r”</th>
<th>R</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental group</td>
<td>Boys</td>
<td>Pre test</td>
<td>25</td>
<td>0.09</td>
<td>0.0081</td>
<td>0.81</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Post test</td>
<td></td>
<td>0.373**</td>
<td>0.137</td>
<td>13.7</td>
</tr>
<tr>
<td></td>
<td>Girls</td>
<td>Pre test</td>
<td>25</td>
<td>0.112</td>
<td>0.0125</td>
<td>1.25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Post test</td>
<td></td>
<td>0.446**</td>
<td>0.198</td>
<td>19.8</td>
</tr>
<tr>
<td>Control group</td>
<td>Boys</td>
<td>Pre test</td>
<td>25</td>
<td>0.061</td>
<td>0.0129</td>
<td>1.29</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Post test</td>
<td></td>
<td>0.023</td>
<td>0.008</td>
<td>0.8</td>
</tr>
<tr>
<td></td>
<td>Girls</td>
<td>Pre test</td>
<td>25</td>
<td>0.11</td>
<td>0.061</td>
<td>0.61</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Post test</td>
<td></td>
<td>0.09</td>
<td>0.09</td>
<td>0.9</td>
</tr>
</tbody>
</table>

*P < 0.05 , **P < 0.01 , ***P< 0.001, N.S= not significant

The correlation co-efficient values show that there is significant relationship between Chemistry achievement test scores and ICT evaluation questionnaire as visual tool. This shows implementation of ICT as visual tool in teaching balancing chemical equations in Chemistry improves the understanding the concept by the students.
Table 3: To show the significant differences in the pre and post achievement test scores of the sample.

<table>
<thead>
<tr>
<th>Group</th>
<th>Gender</th>
<th>Test type</th>
<th>Mean</th>
<th>S.D</th>
<th>“t”</th>
<th>L.S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>Boys</td>
<td>Pre test</td>
<td>62.3</td>
<td>9.87</td>
<td>6.37**</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Post test</td>
<td>70.2</td>
<td>6.1</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Girls</td>
<td>Pre test</td>
<td>69.5</td>
<td>7.46</td>
<td>9.44***</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Post test</td>
<td>77.7</td>
<td>5.09</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control group</td>
<td>Boys</td>
<td>Pre test</td>
<td>64.36</td>
<td>10.55</td>
<td>1.65</td>
<td>N.S</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Post test</td>
<td>66.78</td>
<td>8.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Girls</td>
<td>Pre test</td>
<td>66.89</td>
<td>11.93</td>
<td>1.07</td>
<td>N.S</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Post test</td>
<td>68.05</td>
<td>8.08</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*P < 0.05 , **P < 0.01 , ***P< 0.001, N.S= not significant

The “t” value of the experimental group is significant at 0.001 level for boys and girls of the experimental group showing that implementation ICT as visual tool in teaching – learning Chemistry improves in understanding and application of the concept.

Results and Discussion

Information and Communication Technologies (ICTs) are often used as an "add-on" in many classrooms and in many lesson plans. As, many teachers find that interesting and well-planned tasks, projects, and resources provide a key to harnessing the educational potential of digital resources, Internet communications and interactive multimedia to engage the interest, interaction, and knowledge construction of young learners. ICT integrated teaching –learning model imposes inquiry approach in order to better link relevant new theories or models of learning with practice and to build upon related learner-centered strategies for integrating ICT resources and tools, and to incorporate interdependent functions of learning as information access, communication, and applied interactions. ICT-supported learning activity design provides an inquiry based approach to learning creating a long term impression in the brain. ICT integrated teaching – learning foster critical thinking among learners. It is also clear that each teacher’s orientation and personal theories influence the model of teaching and learning adopted, although the greater the confidence in the technology the greater the propensity for use.
This motivation factor is vital to the success of the project and beyond. In fact it is part of a loop of professional learning that incorporates a number of variables including competence, theories of teaching, subject perceptions and knowledge as well as levels of professional satisfaction resulting in improved learning outcomes or increased classroom interaction and motivation. In addition to the information about a particular concept, ICT integrated teaching–learning model enables promotion of the following aspect in the whole process of learning.

- **Timeliness**: the information available is up-to-date;
- **Emphasis**: highlighting particular aspects of a display or idea
- **Multimodality**: the facility to combine visual, aural, and textual display
- **Accuracy**: items are constructed with greater precision that is realistic manually
- **List**: the facility to set out a choice of resources or actions
- **Template**: the provision of a standard outline structure for individuals to add their own ideas
- **Acquisition**: the entry of data into the ICT device and storage for subsequent processing and display.
- **Dynamism**: processes and representations can be shown in motion
- **Simultaneity**: different processes or forms of display can be shown together
- **Library**: data can stored in an organized way for easy retrieval
- **Linkage**: Sets of information can be linked for easy access or processing

Thus it is concluded that integration of ICT in teaching–learning Science and Mathematics along with didactic approach promotes dynamism, automation and accuracy among learners.

**References**


