International Journal of Computer and Communication Technology

Volume 8 | Issue 1 Article 2

January 2017

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Recommended Citation
Malliga, P.; Venkatesh, N.; and Sambanthan, T.G. (2017) "Problem Centric Instructional Approach for Computer Science & Engineering E-Content Development," *International Journal of Computer and Communication Technology*: Vol. 8 : Iss. 1 , Article 2.
DOI: 10.47893/IJCCT.2017.1391
Available at: https://www.interscience.in/ijcct/vol8/iss1/2

# Problem Centric Instructional Approach for Computer Science & Engineering E-Content Development

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***Abstract*** **-** Instructional strategies for e-content development have to be entirely different from that for traditional printed materials, such as text books and manuals. This is due to the fact that, technically and socially both have different instructional processes. Due to the advent of ICT development in recent times, many Computer Technology subject contents are being uploaded in e-learning modes. Training imparted through e-modes has increased in recent times specifically in India. This paper demonstrates the effectiveness of our suggestion on Real World Problem centric Instructional approach. Specific issues on the e-mode have been inferred through a social study conducted on Indian learners (respondents). The paper justifies the adaptation of 'First Principles of Instruction' through our experimental study. Due to reasons elaborated in the paper this proven Instructional approach using 'First Principles of Instruction' would be well suited for e-content development of Computer Science and Engineering subjects.

***Keywords*** **-** *Computer Science Education; E-content Development; E-learning; Instructional design.*

## I. INTRODUCTION

Quality education needs to be looked upon from multiple perspectives. The first is to ensure that the education offered results in the quality of learning imparted, not mere rote learning as it is often reduced to, in today's education [1]. This educational quality depends upon the learner characteristics of a particular mode of instruction, say classroom delivery or instructions through e-mode. The instructional strategies of a particular mode depend upon specific learner characteristics. For example, obtaining degrees in a particular discipline through regular mode or distance education mode; learning same subject content by a learner from a diploma stream or degree stream or postgraduate stream vary a lot. Therefore learner characteristics play a vital role in the learning process. Hence Instructional strategies and models should vary from course to course, subject to subject and cater to different learner characteristics.

## II. PROBLEM CENTRIC INSTRCUTION

There are a number of Educational theories and ample numbers of Instructional Models have been developed and existing in the educational arena. It is also imperative to note that the type of Educational theory and respective Instructional Model depend a lot of a particular nature of subject content. For instance Computer Science and Engineering (CSE) may be placed under Problem Based Learning (PBL). However, Instructional models for Problem centric content seem to be still evolving, especially for e-content. The recently popularized 'First Principles of Instruction' [2] has been found to be more applicable to problem centric courses like Engineering and Technology, Computer Science and Applications, etc.

Instructional strategies for training through e-content media should be different from that of traditional methods. Many theories have been compared and reported that suit well for delivery through e-content [3]. Carroll's Minimalist theory is one of the best suited theories for Computer based Instructions [4]. But this does not explicitly specify sequencing of instructions and not based on 'Problem centric' approaches. David Merrill's model [2] on the other hand is one such fully developed and proven instructional model which emphasize on Problem centric Approach. Merrill's approach of putting a real-life problem into the centre of an instructional episode is particularly suited to any PBL approach [5]. Besides, this model is developed later to the introduction of Carroll's Minimalist theory for e-content Instructions. Merrill's First Principles of Instruction is a derivative from both cognitive and constructivist theory [6]. This is explained in Figure 1.

Merrill divides any instructional event into five stages with the first one being a Real World problem. The rest four phases, which he calls Activation, Demonstration, Application and Integration are Cognitive structures which could be quantifiable.

Central to his instructional model is a theme of real world situation, called 'Problem'. This model is termed as 'First Principles of Instruction' (see Figure 2). Problem centric approach is proved to be an effective instructional model as it gives importance to learner's motivation as prime importance and it follows a cyclic approach using 'Constructivism' as the principle [7].

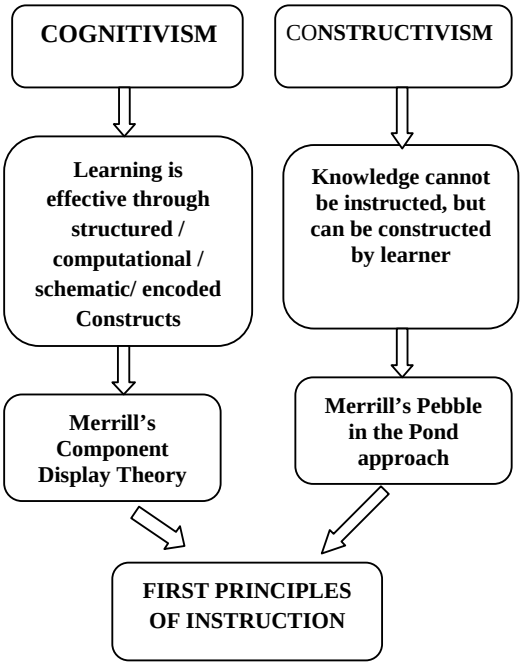


Fig. 1: Development of 'First Principles of Instruction'

Merrill suggests that fundamental principles of instruction should be relied on and these apply regardless of any instructional design model used. In the Merrill's design theory, First Principles of Instruction is emphasized along with the following aspects: the value of using the real-world situations (problems) in the instructional event; the importance of activation of existing knowledge of the learner; the role of demonstration; guided problem solving (Application) and the integration of new knowledge with existing knowledge. This model is based on Information Processing Theory.

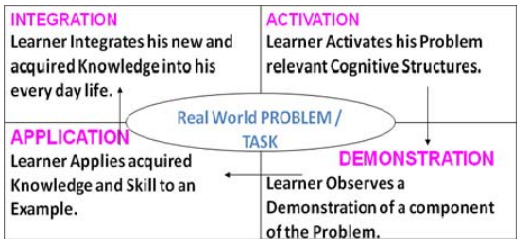


Fig. 2: Five phases of First Principles of Instruction.

Merrill M.D [8] has arrived at learning objects for any e-content development. Instructional episodes in e-content consist of independent objects which are modular and reusable in nature. The arrivals of these learning objects are depicted in Figure 3. Merrill clearly points out that knowledge objects (structured contents such as text and media objects) should be combined with strategy objects (such as Learning objective, Instructional strategy, Learning Activities and Assessment) to make Learning Objects.

## III. DESIGN OF PROBLEM CENTRIC INSTRUCTIONAL APPROACH FOR E-CONTENT

Plethora of e-contents of CSE subjects is available in the Web. Most of these e-contents are found to be in the style and form of text books. Besides, no course objectives have been explicitly spelt out for most of these e-contents. It is thus believed that many users of e-contents do not seriously utilize for rigorous learning. As seen from several published research works [8], that learner characteristic is a very important component that are needed for the development of these kinds of e-contents. Literature also show that e-learning should be objective driven.

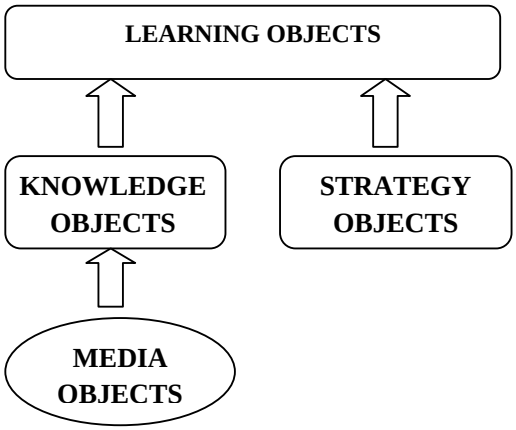


Fig. 3: Knowledge Objects to Learning Objects Conversion

### *A. Case Study*

'National Programme on Technology Enhanced Learning' (NPTEL) is a hugely funded project by Ministry of Human Resource Development, Government. of India which provides e-learning through online Web and Video courses in Engineering (Phase I) (http://nptel.iitm.ac.in). However the learner characteristics of specific target group of specific course of NPTEL is not explicitly made known in the programme, even though the overall course objectives have been specified. As a case study, we have taken the

e-contents (limited to Web courses) of NPTEL for the proposed study. This study was carried out through social survey. Purposive sampling technique has been adopted. A pilot study was administered on 28 learner respondents for validating the questionnaire. The validated questionnaire was used to determine the effectiveness of Instruction in the existing NPTEL e-content of the chosen CSE subject. Over 93% of the total responses of 165 indicated the strong weakness of Instructional strategies adapted in the existing courses.

*B. Design of Problem Centric Instructional Approach*

One subject area of Computer Science and Engineering namely 'Operating Systems' was chosen for the study. The design and development of the Instructional approach was based on David Merrill's 'First Principles of Instruction'. The important concept areas / topics namely 'Device Dependence' and 'Device Independence' of the chosen subject 'Operating Systems' was taken for the experimental study. For example a real life situation was placed central to this instructional episode. The instructional time for each phase for the selected episode and the quantities of Cognitive Structures are tabulated in Table 1 (Instructional episode for 'Device Dependence') and Table 2 (Instructional episode for 'Device Independence'). These instructional episodes were administered to the learners through CD forms.

TABLE I:INSTRUCTIONAL DETAILS OF EPISODE 1

| Episode I | Real World Problem | Activation | Demon-stration | Application | Integration |
|---|---|---|---|---|---|
| Instructional Time (in minutes) | 5 | 3.5 | 4 | 6 | 4 |
| % of Distribution of Cognitive Structures | -- | 20% | 23% | 34% | 23% |

TABLE II : INSTRUCTIONAL DETAILS OF EPISODE 1I

| Episode I | Real World Problem | Activation | Demon-stration | Application | Integration |
|---|---|---|---|---|---|
| Instructional Time (in minutes) | 5 | 3 | 4 | 3 | 5 |
| % of Distribution of Cognitive Structures | -- | 20% | 27% | 20% | 33% |

## IV. FEEDBACK ANALYSIS

A validated questionnaire with 30 social survey questions was designed for the purpose of the study. However feedbacks of only four relevant questions that are related to the focus of this paper are presented. Feedbacks were received from 165 respondents on these questions. The analyses on the feedbacks are discussed and concluding remarks are drawn. The conclusions and recommendations would be of immense use to e-content developers of CSE.

*A. Results and discussions:*

*1) Question on motivating learners through Problem Centric Instructional approach:*

Most of the learners, feel that they are highly motivated while learning the subjects through 'Problem centric approach' (see Figure 4).

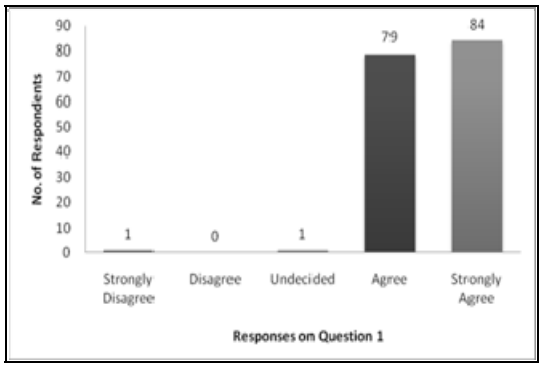


Fig. 4: Distribution of responses on Motivation

This is evidenced by the maximum positive responses (over 98%) provided by them ('Strongly Agree' - 51%; 'Agree' - 48 %). This is a clear indication of the suitability of 'Problem centric approach' for e-content instructions.

*2) Question on the contradiction of Problem centric learning from that of traditional method:*

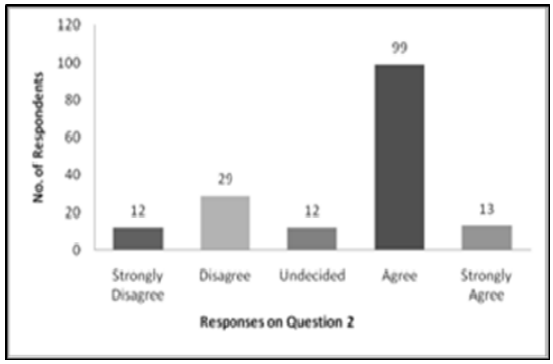


Fig. 5: Distribution of Responses on contradictions with traditional methods

It is observed from the results that the maximum number of responses (60%), among the 75% of the positive responses have agreed that traditional teaching methods contradict with 'Problem Centric' method as shown in Figure 5. This concurs with the findings of many literatures surveyed [9] [10].

*3) Question on the significance of Problem centric instructional approach:*

It is clearly demonstrated from the overwhelming positive responses provided by the respondents (over 96%) that 'Problem Centric' approach is invaluable to instructional approach (see Figure 6). This observation concurs with the conclusions remarked by David Merrill on his 'First Principles of Instruction' [10] [11].

*4) Question on the appropriateness of an appealing real world problems:*

Over three fourths positive responses out of the total responses clearly indicate that the real world problem should be appealing for the relevant topic of Instruction (see Figure 7). This finding indicates that the expression of relevant real world problem would be difficult for the Instructional designers as indicated by researchers [12].

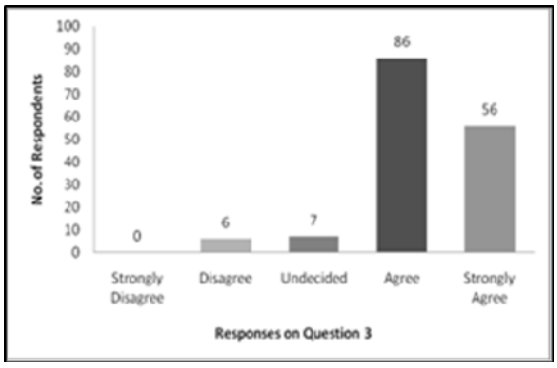


Fig. 6: Distribution of Responses on Instructional Approach

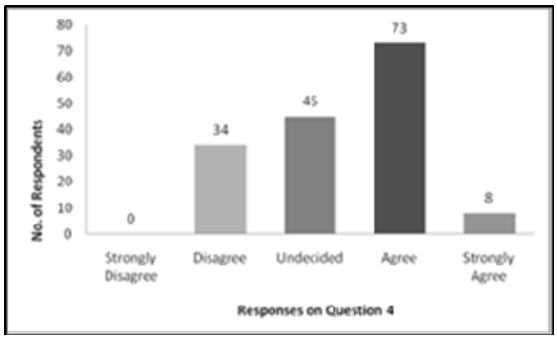


Fig.7: Distribution of Responses on the difficulties of Problem Design

## V. CONCLUSIONS AND RECOMMENDATIONS

- The social survey conducted on the CSE contents of NPTEL reveal that even though the subject content is of high standard, the Instructional approach adapted might not have a base on any Instructional Model.
- It is recommended to revamp the Instructional strategy of CSE contents of NPTEL through a proven Instructional model such as 'First Principles of Instruction'.
- It is demonstrated clearly that Problem Centric Instructional Approach highly motivates the learners.
- It is believed that design of appropriate real world problem for topics of e-content would be a difficult affair for the designers.

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