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An Intelligent Prescription of Content Modelling for A Typical Learner

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***Abstract*—** Confidence Based Learning (CBL) is an innovative technique for teaching and learning mechanism including training on hands-on-practice. The technique revolves around majorly three phases: diagnosis, prescribe and learning. In this paper the authors propose a technique that prescribe a customized learning content in terms of Learning Object (LO) where it identifies the deficiencies from the 2-dimensional assessment. The proposed system also takes care of the dependencies in terms of content as well as pre-requisites as required. The system identifies the average increment of level of confidence and knowledge while prescribing the contents. The system however has certain limitation where despite best effort in customizing content, the trend of the learner is towards downward. In such extreme cases human intervention may be required.

***Keywords*—**CBL, Content Modelling, Content Prescription.

I. INTRODUCTION

CBL [1][2][3] is a new technique used in the area of e-learning where the system assesses the knowledge component as well as level of confidence in that knowledge of the learner. The system unlike most other learning techniques first assesses a learner and subsequently delivers the learning content. CBL is very much dependent on the assessment methodology and any deviation in this regard will leads to detrimental results. Confidence based assessment (CBA) [4][5] is a technique implied by the Learning Management System (LMS) that uses CBL. CBA is a technique that uses a 2-dimensional assessment method for assessment of a learner [6]. The outcome of the CBA in form of deficiency diagnosis forms the basis for the prescribe phase of the CBL [1]. In this research paper the authors propose a technique of prescribing content both in superficial and detailed form depending on the requirement of a typical learner with respect to a learning objective. It may please be noted that to develop level of confidence along with knowledge, there is a requirement for adapting a dynamic learning approach i.e. deep or surface learning.

This article is structured as follows. Analysis of the related works is discussed in Section 2. Proposed prescription model is explained in section 3. Section 4 depicts the results and discussions. Section 5 is designated for conclusion and future scopes.

II. RELATED WORK

Maxwell & Mucklow [7] proposed a e-learning model for Clinical Pharmacology and Therapeutics (CPT) for the medical students. The research article provides better prescription of learning content to the learners. However, there is no customized prescription for individual learners. This has limitation in judgement of learning ability of individual learners.

Shute & Towle proposed an Adaptive e-Learning [8] emphasizing on Aptitude-Treatment Interaction (ATI). Aptitude represent personality traits and Treatment refers to the various conditions in learning. Despite ATI was focused, there were no prior KSA analysis of the individual learner.

Hwang et. al. proposed a personalized computer game-based model [9] to promote education at school level. This not only promote motivation but also improves achievements. However, there is no evidence of the prior analysis of individual knowledge and skill sets.

Chatterjee and Mandal [10] have outlined the structure of LO for CBL based system. They also proposed a weighted marking mechanism in between -3 to 3 depending on the correctness to answer and level of confidence. However, they have not considered the situation of the tasks having prerequisite or interdependencies among themselves.

III. METHODOLOGY

In the proposed technique, a customized learning content is created for a typical learner. The system uses inputs from the 2-dimensional assessment [6] to find the deficiencies. The profile of a typical learner is obtained from the LRS [11] using the technique of data mining.

The content customization is done for a typical learner in a domain. The content proposal is done based on an individual Instructional Objective (IO) in a conventional subject area. Each IO is further divided into several tasks that need to be accomplish by a learner to have mastery status in that IO.

Let us consider an Instructional Objective IO_j . Let us also consider that a customized learning Object LO_{jx} is a content that needs to be delivered to a learner X based on CBA done by the system for the Instructional Objective IOj (eq. i).

$$IO_j = \sum_{i=1}^{n} T_i \quad ..(i)$$

Each task T_i is represented as a point on the two-dimensional space in shape of a quadrilateral given in figure 1.

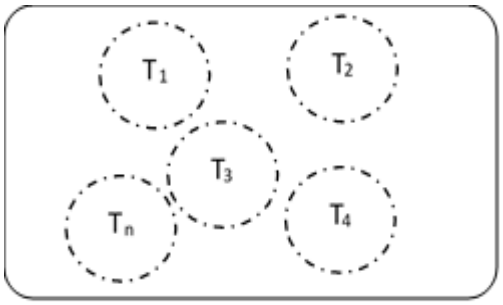

Figure 1. Task Representation in 2-dimensional space

Let us assume the fact that IO_j consists of set of tasks T, where T= {T_1, T_2,.., T_n}

In this situation the following condition may arise:

a) T_i may be partially or fully dependent on T_{i-1}, T_{i-2}, .., T_1.

b) T_i and T_k may be two different tasks that may be mutually exclusive,

c) T_i and T_k may be two different tasks that may be interdependent,

d) $\forall T_i \in T$ they are mutually exclusive and independent

Let us consider a typical example of deficiency diagnosis where T_1, T_2 and T_4 have no prerequisite. T_3 is dependent on T_1 and T_2 and T_5 is dependent on T_3 and T_4. The analysis of deficiency diagnosis will yield the result in form of a typical table given in Table 1 at the initial time t_0.

Table 1. Task & Task Dependencies with Learning Approach & Level at t_0

Task	Task Dependencies	Learning Approach	Average Confidence Level (CL_i)	Level of Learning
T1	NIL	Surface	2.7	No content Req
T2	NIL	Surface	2.6	No content Req
T3	T1, T2	Deep	1.5	Supeficial
T4	NIL	Deep	2.8	No content Req
T5	T3, T4	Deep	-2.4	Detailed

Chatterjee and Mandal [10] proposed an algorithm "Procedure LO_Dev" for a typical learner where CL_i is the average confidence level of a that learner for individual task. This algorithm provides the basis for prescription of LO_{jx} a content for that learner.

A. Algorithm for Content Development

The algorithm for enhanced proposal is given in figure 2. Initialy at time t_0 the learner has the deficiencies in terms of tasks T_i based on the 2-dimensional assessment [6] which are listed in table 1. There may also be cases where a task may be interdependent or will have pre-requisite(s). This brings the requirement for analysis of the learner in multiple iterations. "Procedure Content_Dev" will identify all tasks that are yet to get mastery status for a typical learner. If a particular task is not having interdependent content or pre-requisite, then the "Procedure LO_Dev" [10] is called. However, if the task T_i is having a pre-requisite then "Procedure LO_Dev" and pre-requisite task T_{i-k} which is pre-requisite with respect to task T_i is called.

```
Algorithm 1:
Procedure Content_Dev //Modified procedure
BEGIN
{Select IO for which mastery is not achieved
While(!(∀ Tasks ∈ IOj achieved mastery))
BEGIN
For each task Ti∈ IOj
{ If Ti is independent task and does not have
pre-requiste
{   call Procedure LO_Dev;
}
else if Ti has pre-requsite
{   call Procedure LO_Dev;
    Prescribe Tasks Ti-k where k=i-1 to 1& Ti-k
is a pre-requsite of Ti;
     call Procedure LO_Dev;
}
else if Ti is interdependent on Tk
{   Prescribe Tasks Ti and Tk where i and k
     represent tasks that are interdependent;
    call Procedure LO_Dev;
}
END FOR
    call Procedure Perf_analy;
END WHILE
END
```

Figure 2. Algorithm for Modfied Presciption with Pre-requiste

In case the task T_i is interdependent on task T_k, content for T_i as well as T_k are prescribed. The algorithm 1 generates information in the tabular form for each iteration as given in table 2.

B. Algorithm for Performance Analysis

Algorithm 2 compares the change in average performance of respective tasks though each iteration undergone by a typical learner. The performance analysis is given in equation ii.
At time t_i

$$Avg\_Perf= \sum_{i=0}^{n} Perf[t_i]/(i+1) \quad \ldots(ii)$$

In this typical example given in table 1, performance of learner X for tasks T_3 and T_5 has not reached mastery and hence the learner requires superficial or detailed content with respect to these tasks. Appropriate content is provided to the learner and the learner is subject to re-assessment using Confidence Based Assessment (CBA)[6]. The deficiencies and content proposal for the subsequent iteration is given in table 2.

Table 2. Task & Task Dependencies with Learning Approach & Level at t_1

Task	Task Dependencies	Learning Approach	Average Confidence Level (CL_i)	Level of Learning
T3	T1, T2	Deep	1.7	Supeficial
T5	T3, T4	Deep	-2.1	Detailed

Similarly, after Deficiency Diagnosis (DD) of each iteration at time T_2, T_3, and T_4 similarly performance will be obtained.

The performance analysis algorithm i.e. algorithm 2 is given in figure 3.

```
Algorithm 2:
Procedure Perf_analy //Performance analysis
//procedure
BEGIN
{Select IO for which mastery is not achieved
While(!(∀ Tasks ∈ IOj achieved mastery))
BEGIN
For each task Ti∈ IOj
{ If Ti is independent task and does not have
pre-requiste
{   If( AVG(CLi )> CLi[t0])
    {
        Content Proposal is ok
    }
    Else
    {
        Content Proposal needs revision
    }
}
Else if Ti has pre-requiste or Ti is
interdependent on Tk
{   If((AVG(CLi)&&AVG(CLi-k)> CLi && CLi-k)||
      (AVG(CLi)&&AVG(CLk)> CLi && CLk)
   {
        Content Proposal is ok
    }
    Else
    {
        Content Proposal needs revision
    }
}
Else call Procedure Perf_analy
}
END FOR
END WHILE
END
```

"Procedure Perf_analy" measure the performance of the average increment in the level of confidence of the respective task if the task is independent as well as confidence level in tasks that are associated with a particular task T_i.

IV. RESULTS AND DISCUSSION

In the proposed technique, the prescription of the customized LO_{jx} for a particular IO_j customized for learner X at a given instant. This include analysis of the finding of deficiencies in respect to Task T_i for a given instructional objective IO_j. This uses the recursive technique of identifying the lacunas and providing content overcoming related lacunas. The system takes the average increment of knowledge as well as confidence level to provide better content management. This also looks for the pre-requisite as well as interdependent task in course of content prescription. Table 3 shows how better performance can be achieved using the proposed techniques and provides information about the proposed advantages of implementation.

Table 3. Comparison of existing and proposed system

Sl. No.	Criteria	Existing System	Proposed System	Results
1	Analysis based on Task within IO.	Yes	Yes	Same as existing.
2	Analysis of Tasks that has Pre-requiste.	No	Yes	Better
3	Analysis of Tasks that are interdependent.	No	Yes	Better
4	Calculation of Average increment of CL in each iteration.	No	Yes	Provides better feedback to content customization and prescbing content.
5	Conclusive of learner's development / failure with respect to content prescription.	No	Yes	Provides conclusive information about development of learner or failure of the system to propose content.

V. CONCLUSION AND FUTURE SCOPE

This research work has been accomplished to prescribe a learning content in form of a customized LO for a particular IO targeted to a typical learner. The system is actualized utilizing the idea of incremental knowledge and confidence level for the targeted learner. The authors have considered the 2-dimensional assessment given in article by Chatterjee &

Mandal [6] for the computation of deficiencies. The limitations of suggestive prescription referred by Chatterjee & Mandal [10] has been overcome by considering the pre-requisite(s) and interdependent task(s) in terms of iterative process. However, the system at times identify that the average CL is having a trend downwards i.e. in lieu of development of a learner it leads to failure to advise appropriate content. Under these circumstances the system cannot handle the situation and needs human intervention leading to a better prescription of the content.

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Authors Profile

Mr. R. Chatterjee pursed B.E. (Computer Science) from Karnatak University, Dharwad, Karnataka, in 1999 and his M. Tech. in Multimedia and Software Systems from West Bengal University of Technology, West Bengal India in 2011. He is currently pursuing Ph.D. and currently working as Assistant Professor in Department of Computer Sciences and Engineering, National Institute of Technical Teachers' Training and Research, Kolkata, India for last 18 years He is a life member of AIAER since 2008, He has published more than 22 research papers in reputed international journals and conferences including IEEE. His research work focuses on E-Learning, SDN, Cryptography, Network Security, He has 19 years of teaching & 13 years of Research Experience.

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