A Novel Learning Object Framework for Confidence Based Learning

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Abstract— Confidence Based Learning (CBL) is a novel method in Teaching-Learning system where the process measures both the knowledge and confidence of a particular learner. In this paper a new framework has been proposed for Learning Objects (LO) suited for CBL. The proposal also takes care of the requirement for implementation including Learning Object Metadata (LOM). The novel framework proposed in this paper is used for prescribing learning content. The results show the progress in the performance of a typical learner through multiple iterations.

Keywords—Confidence based Learning (CBL); e-learning; Learning Objects, Learning Object Metadata(LOM).

I. INTRODUCTION

Confidence Based Learning (CBL) [1][2] is a new methodology in Teaching and Learning System, where the system not only assess the knowledge of a learner, but also measures the level of confidence about the knowledge. The methodology uses 2-dimensional assessment to determine knowledge as well as confidence level. This assessment is also known as Confidence Based Assessment (CBA). CBL is typically divided into three phases: i) Diagnose, ii) Prescribe, and iii) Learning. In diagnose phase, the system tries to assess the existing knowledge a learner has with level of confidence. In prescribe phase a customized content is provided based on CBA. The learning phase takes care of the learning process with confidence building in the newly acquired paradigm of knowledge.

This research paper is organized as follows. In section II, the overall learning process, learning approaches and role of learning object in the process of learning has been discussed. In section III, conventional learning objects and its limitation is being discussed in context to CBL based system. Section IV proposes the design for LO based on CBL. In section V, the results and comparisons are given that of. Section VI presents the conclusion and future scopes.

II. THE PROCESS OF LEARNING AND RELATED ISSUES

The process of learning is a very important activity in the CBL system. It has to be efficient as well as specific as per the requirement. Therefore the learning process has to depend on learning approaches as well as on the design of learning objects. In this section, learning process is explained in section A. Section B deals with various approaches of learning and section C deals with learning object (LO).

A. Learning

Learning is the process or activity of acquiring new knowledge, behavior, skill, values or preferences. It is also activity of augmentation of existing knowledge or skill-set or adaptation of new behavioral pattern. This process of learning is applicable to human beings, animals and machines. According to Bloom’s Taxonomy [3], learning is divided into three domains: cognitive, adaptive and psychomotor. The cognitive domain has six levels. While learning takes place, one of the prominent behavioral changes is development of confidence for evaluation in a particular situation. This is very much required in the real life situation.

B. Learning Approaches

Learning can be done using two different approaches depending on the situation. The approaches are commonly referred to as: Surface Learning and Deep Learning [4]. Fig. 1 shows the various level of cognitive domain where surface and deep learning is shown at the desired level.

![Levels of Cognitive Domain with surface and deep learning](image)

Surface learning is referred to knowledge acquisition and comprehension. Deep Learning refers to application of knowledge through analysis which leads to solving problem. In order to build confidence among the learners it is generally...
observed that deep learning is normally adapted in CBL environment. However, in certain situations, a surface learning may be prescribed where a learner may have doubt in reference to a particular context where confidence is lacking.

C. Learning Object

A learning object (LO) \([5][6][7][8]\) is a chunk of knowledge which ideally addressed to one Instructional or Learning Objective. It is a piece of digital (or in some cases non-digital) chunk of information that is reusable. It primarily consists of set of instructions, activities related to learning and items for assessment. The learning object contains some additional piece of information used for searching and indexing the LO for storage and retrieval in a digital storage system. This additional piece of information is known as Learning Object Metadata (LOM). IEEE LOM \([9]\) is a standard used to defined metadata related to LO. The LOs usually have properties that include ‘reusability’, ‘interoperability’, ‘durability’, ‘accessibility’, ‘interchangeability’, and ‘scalability’.

III. CONVENTIONAL LEARNING OBJECTS

Conventional Learning Objects (LOs) \([5][8]\) are piece of digital information that helps learning. Traditionally, LOs have set of instructions, interactivities, and item bank for assessment. Instructions are delivered using multimedia objects such as texts, audio, graphics, animation and videos. Typically, LOs have five to seven minutes of instructions followed by interactive learning activities.

In the traditional system of design of LOs, the existing knowledge and confidence of learners are not taken into account. The LOs are basically designed and developed on the basis of Instructional Objectives (IOs) based on a particular course curriculum \([10]\). There is a lacking of adaptive nature of Learning Objects.

The adaptive nature of the LOs depends on the concept of surface vs. deep learning \([4]\). It may further be noted that based on the confidence level of a learner superficial vs detailed learning may be imparted. This may be possible once a learner is evaluated through Confidence Based Assessment (CBA) that normally conventional e-learning system does not have. Deficiency Diagnosis (DD) is a process that identifies knowledge, skill and confidence gap from the CBA \([11][12]\). The gaps are mapped using a two dimensional mapping tools known as Knowledge Quadrants given in fig 2.

Hence the implementation of surface vs. deep learning as well as superficial vs. detailed learning may not be possible using conventional LOs. This implies a requirement of customized learning objects which is being proposed in the next section.

IV. PROPOSED LO FOR CBL SYSTEMS

In the proposed methodology, the limitations of the conventional LO has been overcome by incorporating a novel framework for the LOs. The details of the proposed framework are given in section A. The mathematical model of proposed framework is given in section B. Implementation is given in section C and metadata implementation is given in section D.

A. Proposal for novel framework for LO

A new framework for a Learning Object (LO) has been proposed which may be helpful in deep learning as well as surface learning. This may overcome the existing limitation of a learning object used in CBL system. In this framework the LO is classified into five sub-categories. The type of media objects and the relationship with metadata for identification and access during storage and retrieval is also explicitly declared in the framework. The schematic diagram of the proposed learning object framework is given in fig 3.

![Fig. 3 Schematic diagram of proposed LO framework for each task](image-url)

Each of the sub-components has a specific role in the knowledge representation and knowledge dissemination. The main reason of dividing an LO into proposed 5 sub-components is as follows: Most of the LOs are normally designed to deliver and disseminate concept, terminologies, etc. In order to elaborate knowledge, extra knowledge and elaborations are added. References are also a part of an extra knowledge that may be acquired by a learner by referring them. Examples may develop full emphasis for understanding a concept. It also helps in comprehension of the knowledge. Examples may develop confidence of a learner through application of the knowledge. Assessment helps the system to identify the transfer of knowledge to a learner. Pre-requisite has a vital role in the proposed framework for LO. It may happen that the concept of a learner is not clear because the learner has problem with pre-requisite which may prohibit him from learning. From the above analysis, it may be concluded the requirement of a novel LO for CBL. The various attributes and features that each sub-components address in this proposed learning object (LO) is...
The learning object (LO) framework with respect to CBL is

i) learning object for a particular learner

conditions are considered for development of a customized

defined with the help of a mathematical model. The following

references and examples deep learning is prescribed with text,

and text and audio as media objects. For extra knowledge,

concepts, terminologies and taxonomies with superficial mode

listed in table 1. Learners use surfaces learning approach for

surface learning approach. Mostly assessment uses text object.

However, in some situations, extra knowledge is referred in

audio, image, animation and video used as media objects.

The learning approach (LA) for individual tasks / activity

has to be in terms of surface learning, where the value of

LA can be also be prescribed as 3 to 6, corresponding to application,

analysis, synthesis and evaluation.

iii) Finally, depending on the level of confidence a learner has

on his /her knowledge, it refers to superficial learning or
detailed learning. The confidence level \( CL_{ki} \) for each
indvidual MCQ has to be mapped to each individual task
/activity \( t_i \) in a particular LO. The value \( CL_{ki} \) can be
defined as confidence level of individual learner with
respect to that particular task \( t_i \) where \( 1 \leq k \leq m \) and \( m \) is
the maximum number of learner supported by the system.

The mathematical model for development of customized LO
for a particular learner \( k \) is defined in equation (1).

\[
LO_k = \sum_{i=1}^{n} f(t, LA_i) \times CL_{ki} 
\]

C. Implementation of Proposed LO using SCORM

The proposed LO is implemented using Sharable Content
Object Reference Model (SCORM) 2004 (4th edition) standard
developed by Advance Distributed Learning (ADL)[13]. The
Content Aggregation Model (CAM) of SCORM is followed
and implemented as a Package Interchange Format (PIF)
that is independent of any LMS. The imsmanifest.xml file
contains the details of the assets that are digital files
containing subject matter that will be developed using
the proposed LO framework using various multimedia objects.

D. Metadata implementation using xml

In multimedia based system, metadata is an important
component. Metadata helps in searching and indexing of
various media objects. Metadata becomes an inseparable
component as most of LOs contains multimedia objects [14].

Metadata related to Learning Objects are often known as
Learning Object Metadata (LOM). A standard was proposed by
IEEE known as IEEE LOM [9]. IEEE LOM standard uses
XML to implement metadata as XML is platform independent
and supports interoperability.

The authors of this research paper have closely analyzed
the LOM standard. They propose a number of adaptation /
mmodifications / extension that may be enhance suitability of
LOs for CBL system.

Metadata implementation in the proposed framework is done
using XML [15][16]. A typical xml representation of the LOM
suitable for CBL is given in fig. 4.

B. Mathematical model for Learning Object

The learning object (LO) framework with respect to CBL is
defined with the help of a mathematical model. The following
conditions are considered for development of a customized
learning object for a particular learner \( K \). They are:

i) Each individual LO is based on the instructional
objectives, where individual instructional objective may
comprise of activities or tasks that are atomic in nature. A
set of tasks/activities \( T \) may be defined where \( t_i \) are the
individual tasks, \( t_i \in T \) and \( 1 \leq i \leq n \), where \( n \) is defined as
the totals number of tasks for a particular LO.

ii) The learning approach (LA) for individual tasks / activity
has to be in terms of surface learning, where the value of
LA is 1 or 2, corresponding to knowledge or
comprehension. The learning approach (LA) value may
also be prescribed as 3 to 6, corresponding to application,
analysis, synthesis and evaluation.

iii) Finally, depending on the level of confidence a learner has
on his /her knowledge, it refers to superficial learning or
detailed learning. The confidence level \( CL_{ki} \) for each
individual MCQ has to be mapped to each individual task
/activity \( t_i \) in a particular LO. The value \( CL_{ki} \) can be
defined as confidence level of individual learner with
respect to that particular task \( t_i \) where \( 1 \leq k \leq m \) and \( m \) is
the maximum number of learner supported by the system.

The mathematical model for development of customized LO
for a particular learner \( k \) is defined in equation (1).

\[
LO_k = \sum_{i=1}^{n} f(t, LA_i) \times CL_{ki} 
\]

Fig.4 A typical xml metadata representation.
Moreover, an ontology based annotation [17] may further help in searching and indexing of the learning objects.

V. THE METHODOLOGY FOR CUSTOMIZED LO

This section describes how a customized LO is created for an individual learner. The Instructor creates a number of Multiple Choice Questions (MCQs) related to one Instructional Objective in a repository known as Item Bank (IB). The Instructional Objective is further divided into tasks or competencies \( ti \), where \( t_1, t_2, \ldots, t_n \) belong to a set of tasks \( T \). For a particular learner \( K \) a set of MCQ is chosen randomly. This set of MCQ will be used for assessment prior to delivery of any learning content. Individual question \( Q_p \) is mapped to task \( t_i \). It is normally assumed that uniformity is maintained in distribution of MCQs related to various tasks within the purview of an Instructional Objective. The procedure ‘Factor’ is used to obtain the absolute confidence level \( cl_p \) for a particular learner \( K \) with respect to MCQ \( Q_p \). The relation is clearly given in table 2. For a given MCQ \( Q_p \), if the answer is correct and the confidence level is high \( cl_p = 3 \); if the answer is incorrect and confidence level is high \( cl_p = -3 \) and likewise. The average confidence level to evaluate MCQs mapped to a particular task \( t_i \), is denoted by \( CL_i \).

The learning approach for a particular task \( t_i \) is determined by analyzing the association of each MCQ to the level of cognitive domain shown in fig I. The levels range from 1 to 6. If the majority of MCQs lie in the range of 1 and 2 surface learning approach is opted, otherwise deep learning approach is opted for a particular task \( t_i \).

The approach for creating a customized LO depends on Learning Approach \( LA_i \) for the task \( t_i \) and average confidence level \( CL \) for that task \( t_i \). The authors have categories \( CL_i \) in four (4) different range \( CL_i \geq 2.5, CL_i \leq 2.5 \) and \( CL_i \geq 1, CL_i < 2.5 \) and \( CL_i < -2 \). It was observed during the experiment that if a learner \( K \) has attempted 80% of the MCQs related to one particular task \( t_i \) with high level of confidence then he/she may be exempted from learning the content related to that particular task \( t_i \). Hence for obtaining mastery the value of 2.5 or above is selected.

**Algorithm 1.**

**Procedure** \( \text{LO}_\text{Dev} \) //for an individual learner \( K \)

// This procedure illustrates how a customized Learning Object (LO) can be developed.
// An Item Bank of MCQs are created and each item is terms as a question \( Q_p \). Each MCQ \( Q_p \) is associated with a task \( t_i \), and six level of knowledge pyramid where \( t_1, t_2, \ldots, t_n \) ∈ \( T \). Function factor maps the correctness of the answer with three level of confidence. Each correct answer has (+1) marks and incorrect answer (-1).

// The \( CL_i \) is the product of Confidence Level and answer for a particular question \( Q_p \).
// \( CL_i \) is the average value of confidence level \( (cl_i) \) for questions mapped to one particular task \( t_i \). \( LA_i \) is the Learning Approach for a complete Task \( t_i \)

Begin

\[
\text{cl}_p \leftarrow \text{factor(Confidence Level } (Q_p) \text{ and Answer}(Q_p))
\]

\[
\text{if } \{(\text{LA}_i = \text{"Surface"}) \lor (\text{LA}_i = \text{"Deep"})\}
\]

\[
\text{SLC} = \text{SLC} + 1;
\]

\[
\text{else}
\]

\[
\text{DLC} = \text{DLC} + 1;
\]

\[
\text{CL}_i = \text{AVG}(\text{cl}_p) // \text{average confidence level for a set of questions mapped to task } t_i;
\]

\[
\text{if } (\text{SLC} > \text{DLC})
\]

\[\text{LA}_i \leftarrow "\text{Surface Learning}"
\]

\[\text{else}
\]

\[\text{LA}_i \leftarrow "\text{Deep Learning}"
\]

\[\text{END}.
\]

For each task \( t_i \) ∈ \( \text{IO}_k \), where \( 1 \leq i \leq n \)

Begin

\[
\text{if } (\text{CL}_i > 2.5)
\]

\[\text{Status}(t_i) = \text{"mastery"};\]

\[\text{No Learning Content Required;}
\]

\[\text{else if } (\text{CL}_i < 2.5 \text{ and } \text{CL}_i > 1)
\]

\[\text{status}(t_i) = \text{"doubt"};
\]

\[\text{if } (\text{LA}_i = \text{"Surface Learning"
\[}\text{add Concept/Terminologies/Taxonomies to LO;}
\]

\[\text{else if } (\text{LA}_i = \text{"Deep Learning"
\[}\text{add Concept/Terminologies/Taxonomies and Extra knowledge Reference to LO;}
\]

\[\text{else if } (\text{CL}_i \leq 1 \text{ and } \text{CL}_i \geq -2)
\]

\[\text{status}(t_i) = \text{"Ignorant"};
\]

\[\text{if } (\text{LA}_i = \text{"Surface Learning"
\[}\text{add Concept/Terminologies/Taxonomies and Extra knowledge Reference to LO;}
\]

\[\text{else if } (\text{LA}_i = \text{"Deep Learning"
\[}\text{add Extra knowledge Reference, Examples and Assessment to LO;}
\]

\[\text{else if } (\text{CL}_i \leq -2)
\]

\[\text{status}(t_i) = \text{"Misconception";
\[}\text{add Concept/Terminologies/Taxonomies, Extra knowledge Reference, Examples, Assessment, Pre-requisite to LO;}
\]

\[\text{END}
\]

\[\text{END}
\]

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Answer to MCQ</th>
<th>Confidence Level</th>
<th>( cl_p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Incorrect</td>
<td>High</td>
<td>-3</td>
</tr>
<tr>
<td>2</td>
<td>Incorrect</td>
<td>Medium</td>
<td>-2</td>
</tr>
<tr>
<td>3</td>
<td>Incorrect</td>
<td>Low</td>
<td>-1</td>
</tr>
<tr>
<td>4</td>
<td>Correct</td>
<td>Low</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Correct</td>
<td>Medium</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>Correct</td>
<td>High</td>
<td>3</td>
</tr>
</tbody>
</table>

**TABLE II.** \( cl_p \) FROM ANSWER AND CONFIDENCE LEVEL (FACTOR)
VI. RESULTS

The performance of the proposed LO is compared to the exiting LO, on the basis of the criteria given in table III. From the table III, it is observed that the proposed LO has certain features over the existing LO. The new LO provide support for 2-D assessment which may not be possible with the existing LO. It also provides better accommodation of different learning approaches. Learning mode such as superficial as well as detailed is supported in this type of LO framework. This in turns have better evaluation and assessment for a learner that actually helps the learner in the place of work.

TABLE III. COMPRISON OF EXISTING AND PROPOSED LO.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Criteria</th>
<th>Existing LO</th>
<th>Proposed New LO</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Support for 2-D assessment</td>
<td>Absent</td>
<td>Present</td>
<td>Better performance analysis for a learner</td>
</tr>
<tr>
<td>2</td>
<td>Support for various learning approaches</td>
<td>Absent</td>
<td>Present</td>
<td>Better knowledge comprehension and application</td>
</tr>
<tr>
<td>3</td>
<td>Support various Learning Mode</td>
<td>Absent</td>
<td>Present</td>
<td>Makes the learning process measurable, accountable and efficient</td>
</tr>
<tr>
<td>4</td>
<td>Evaluation and decision making</td>
<td>Poor needs improvement</td>
<td>Better understanding of critical situation</td>
<td>Able to make decision based on the actual situation</td>
</tr>
</tbody>
</table>

The performance of an individual learner is given in the following section. The learner is initially evaluated with 20 numbers of MCQ given in set Qk randomly chosen from the Item Bank IB. Each MCQ in the set Qk is associated with a level knowledge pyramid typically in the range 1 to 6. The assessment is typically done with 4 tasks, T1 to T4. The performance of the learner through five iterations, which he took to reach mastery for all four tasks is given through table IV to VIII. It provides a holistic view of the components of the Learning Object (LO). In the 1st iteration shown in table IV, the learner K has ‘surface learning’ approach for task T1 and T3, and ‘deep learning’ approach for task T2 and T4. Component of Learning Object for first three tasks are ‘Add Concept / Terminologies / Taxonomies to LO’ and for the fourth task ‘Add Extra knowledge Reference, Examples and Assessment to LO’. However, in the 5th iteration shown in table VIII, the learner K has reaches the same status as doubt. The component of LO is prescribed as ‘Add Extra knowledge Reference, Examples and Assessment to LO’.

TABLE IV. ASSESSMENT OF LEARNER THROUGH 1ST ITERATION.

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Status</th>
<th>LA</th>
<th>Component of Learning Object</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>Doubt</td>
<td>Surface Learning</td>
<td>Add Concept / Terminologies / Taxonomies to LO</td>
</tr>
<tr>
<td>T2</td>
<td>Doubt</td>
<td>Deep Learning</td>
<td>Add Concept / Terminologies / Taxonomies and Extra knowledge Reference to LO</td>
</tr>
<tr>
<td>T3</td>
<td>Doubt</td>
<td>Surface Learning</td>
<td>Add Concept / Terminologies / Taxonomies to LO</td>
</tr>
<tr>
<td>T4</td>
<td>Ignorant</td>
<td>Deep Learning</td>
<td>Add Extra knowledge Reference, Examples and Assessment to LO</td>
</tr>
</tbody>
</table>

In the 2nd iteration shown in table V, the learner K has ‘doubt’ for task T1 and T3, ‘mastery’ for T2 and for T4 he is ‘ignorant’. The system prescribes surface learning approach for task T1 and T3 and deep learning for task T2 and T4. Component of Learning Object for T1 and T3 tasks are ‘Add Concept / Terminologies / Taxonomies to LO’ and for the fourth task ‘Add Extra knowledge Reference, Examples and Assessment to LO’. However, as the learner attains ‘mastery’ for task T2. ‘No Learning Content is required’.

TABLE V. ASSESSMENT OF LEARNER THROUGH 2ND ITERATION.

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Status</th>
<th>LA</th>
<th>Component of Learning Object</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>Doubt</td>
<td>Surface Learning</td>
<td>Add Concept / Terminologies / Taxonomies to LO</td>
</tr>
<tr>
<td>T2</td>
<td>Mastery</td>
<td>Deep Learning</td>
<td>No Learning Content is Required</td>
</tr>
<tr>
<td>T3</td>
<td>Doubt</td>
<td>Surface Learning</td>
<td>Add Concept / Terminologies / Taxonomies to LO</td>
</tr>
<tr>
<td>T4</td>
<td>Ignorant</td>
<td>Deep Learning</td>
<td>Add Extra knowledge Reference, Examples and Assessment to LO</td>
</tr>
</tbody>
</table>

In the 3rd iteration shown in table VI, the learner K has similar status for the first three tasks. In this iteration for T4 the learner now has status as doubt. The component of LO is prescribed as ‘Add Extra knowledge Reference, Examples and Assessment to LO’.

TABLE VI. ASSESSMENT OF LEARNER THROUGH 3RD ITERATION.

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Status</th>
<th>LA</th>
<th>Component of Learning Object</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>Doubt</td>
<td>Surface Learning</td>
<td>Add Concept / Terminologies / Taxonomies to LO</td>
</tr>
<tr>
<td>T2</td>
<td>Mastery</td>
<td>Deep Learning</td>
<td>No Learning Content is Required</td>
</tr>
<tr>
<td>T3</td>
<td>Doubt</td>
<td>Surface Learning</td>
<td>Add Concept / Terminologies / Taxonomies to LO</td>
</tr>
<tr>
<td>T4</td>
<td>Doubt</td>
<td>Deep Learning</td>
<td>Add Concept / Terminologies / Taxonomies and Extra knowledge Reference to LO</td>
</tr>
</tbody>
</table>

In the 4th iteration shown in table VII, the learner K has reached ‘mastery’ status for the first two tasks i.e. T1 and T2. However, status of tasks T3 and T4 remains same. In the 5th iteration, the learner manages to obtain ‘mastery’ in all four tasks shown in table VIII.

TABLE VII. ASSESSMENT OF LEARNER THROUGH 4TH ITERATION.

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Status</th>
<th>LA</th>
<th>Component of Learning Object</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>Mastery</td>
<td>Surface Learning</td>
<td>No Learning Content is Required</td>
</tr>
<tr>
<td>T2</td>
<td>Mastery</td>
<td>Deep Learning</td>
<td>No Learning Content is Required</td>
</tr>
<tr>
<td>T3</td>
<td>Doubt</td>
<td>Surface Learning</td>
<td>Add Concept / Terminologies / Taxonomies to LO</td>
</tr>
<tr>
<td>T4</td>
<td>Doubt</td>
<td>Deep Learning</td>
<td>Add Concept / Terminologies / Taxonomies and Extra knowledge Reference to LO</td>
</tr>
</tbody>
</table>

TABLE VIII. ASSESSMENT OF LEARNER THROUGH 5TH ITERATION.

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Status</th>
<th>LA</th>
<th>Component of Learning Object</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>Mastery</td>
<td>Surface Learning</td>
<td>No Learning Content is Required</td>
</tr>
<tr>
<td>T2</td>
<td>Mastery</td>
<td>Deep Learning</td>
<td>No Learning Content is Required</td>
</tr>
<tr>
<td>T3</td>
<td>Mastery</td>
<td>Surface Learning</td>
<td>No Learning Content is Required</td>
</tr>
<tr>
<td>T4</td>
<td>Mastery</td>
<td>Deep Learning</td>
<td>No Learning Content is Required</td>
</tr>
</tbody>
</table>
Fig 5, shows the progress of learner K through multiple iteration of assessment leading to obtaining ‘mastery’ status for all four tasks in the Instructional Objective. The performance related to each tasks continuously improves with every iteration the learner taken through 2-dimensional assessment.

VII. CONCLUSION AND FUTURE SCOPE
In the present research work, the authors propose the requirement of a novel LO in context of the CBL based system. The 2-dimensional assessment technique is complementary for the implementation of the CBL system. However, the 2-dimensions assessment process has not been taken into account which may be the future scope of research. Further, the association of MCQ to level of knowledge pyramid has to take manually as the system is unable to map these level to each MCQs. However, in the future research activity intelligent computing techniques may be proposed that will automatically map the MCQs to level of knowledge pyramid to decide the learning approach for individual tasks.

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REFERENCES