

A Proposed Metric for Estimating the Effectiveness of Reusing Learning Objects

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Abstract

This paper aims to estimate the effectiveness of reusing learning object (LO) by evaluating the most affected aspects in reusing LO by specialized reviewers. In this study we propose a metric aims to give very accurate results about the effectiveness of reusing LO, it can be done by letting a group of reviewers cooperate in reviewing every LO. Every reviewer, reviews only his/ her specialized area.

The reviewers of this metric are categorized into three groups; academic, technical and students while the evaluated elements are categorized into eight categories; gender, re-tasking & repurposing, accessibility, appropriateness, content quality, metadata, motivation and usability.

A comparison to the results of the proposed metric vice the most famous learning objects' metrics is done through this study to indicate the reliability and accurateness of the proposed metric compared with the other metrics.

Keywords: learning objects evaluation, learning objects metric, LOREM, learning objects reusability

I. INTRODUCTION

This paper introduces LOREM as a based metric that integrally evaluates learning objects in order to be re-used in other context.

Several definitions have been proposed to define learning object, the definition given by (Wiley 2000) is that "LO is any entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning". Another definition of (Learning Technology Standards Committee, 2002) is: "a learning object is defined as any entity -digital or non-digital- that may be used for learning, education or training". Martinez, (2000) considered learning objects as content objects used for instructional purposes.

According to Wagner (2002) "Learning objects are commonly viewed as the smallest element of stand-alone information required for an individual to achieve an enabling performance objective or outcome". While Polsani (2003) involved the "reuse" term in the definition of

the learning object itself that his definition is "an independent and self-standing unit of learning content that is predisposed to reuse in multiple instructional contexts" and that the one we adopt during this research.

As a result to the increasing in the quantity of learning objects and the number of learning object repositories, learning objects evaluation became very important issue, to facilitate the process of finding and using learning objects for both of classroom and online course. (Haughey and Muirhead, 2005). User usually search for specific types of learning objects with specific proprieties to achieve certain goals, to make sure that the chosen learning object will achieve these goals effectively, it has to be previously evaluated.

There are several current metrics specialized in evaluating learning objects as (c.f MERLOT, LREM, The Convergent Participation Model...etc) while these metrics covering essential aspects in evolution, they enables all reviewers who study or work in the learning filed (as teacher, LO developers, etc) to evaluate all elements without paying attention to their specialization which affect their capability on evaluate specific elements so we aimed to take advanced step in the field of learning objects evaluation by proposing a metric distinguish between reviewers and gives them authorization to evaluate learning objects based on their work area.

II. LITERATURE REVIEW AND SIGNIFICANT PRIOR RESEARCH

By surveying the most of researches in this field (c.f merlot, Irem, the convergent participation model...etc), we found that there are several metrics have been dedicated to the same purpose but the criteria of these metrics are differentiated from one to another. the most familiar and reliable one up till now is metric entitled "LORI.; learning object review instrument" which depends on nine aspects to determine the effectiveness of reusing learning objects. by the way LORI. is extending the aspects which have been used in another metric entitled "merlot", the second one depends on three aspects only. as "LORI." is one of the most reliable metrics in this filed, many other metrics build several ideas as extension to LORI.

Users search for learning objects in both of repositories that have the metadata gathered with the learning objects on a same centralized server, and repositories that have only metadata and links for downloading learning objects

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from other distributed links on the internet. There are function categories of these repositories (Vargo, Nesbit, Belfer, & Archambault 2003)

- Commercial Repositories: these repositories offer services to instructors and course developers, like publishers' websites that provides instructors who orders textbook with related teaching resources such as: simulations, presentations, test items banks....etc.

- Corporate Repositories: there are two categories of corporate repositories; the first one provided by commercial e-learning providers who willing to support their course development and related activities, the other one used in large companies and organizations for the purpose of training for their members. Open-access Repositories: provided by union of educational organizations.

- Open-access repositories: Offered by educational associations, the learning objects of these repositories are usually provided by participating institutions or individual educators.

Evaluation process is involved in every aspect of LO instruction designing (Williams 2000)

- Clarification of the LOs users.
- Determining the needs of the supposed LO.
- Supposing alternatives ways to fulfill the needs
- Supposing the design.
- Building the prototypes using several LOs' combinations.
- Implementing the prototypes.
- Managing the experience of learning.
- Enhancing the evaluation itself.

According to (Rodríguez, Doderó and Sánchez-Alonso 2008), when measuring the reusability of object-oriented software we should follow four steps:

1. Identifying and studying the aspects of learning objects and the factors which having impact on reusing capability.
2. Defining metrics for measuring the factors of reusability that have been identified, based upon analysis of learning objects metadata (LOM) standers and the learning object structure.
3. Formulating an appropriate evaluation model formed by aggregation of the metrics according to their significant for evaluating reusability.
4. Evaluating the model using the formulated model.

Hence we are analyzing the most famous metrics of learning objects in order to building the proposed metric based on previous infrastructure

MERLOT is an open-access repository that supports user with both of evaluated and unevaluated learning objects, in descending order of quality rating, with unevaluated objects at the end of the list.

According to MERLOT approach (www.merlot.org), there are 3 categories of evaluation standards:

Quality of Content, Effectiveness as a Teaching-Learning Tool& Ease of Use

Another famous metric is LORI. According to (Nesbit, Belfer and Leacock 2004) LORI is an online instrument, has been developed as a service on (www.elera.net) website for evaluating the learning objects in learning objects repositories.

In LORI, reviewers state their rating and comments based on nine items to evaluate learning object:

Content Quality, learning Goal Alignment, feedback and Adaptation, motivation, presentation design, interaction usability, accessibility, reusability and standards compliance.

The rating scale of every item of these nine items is consisting of 5 levels. If learning object is not relevant to the specific criterion or reviewer are unable to evaluate it according to that criterion, it signed as "not applicable".

III. RESEARCH METHODOLOGY

As we mentioned earlier that current learning objects evaluation metrics as (c.f MERLOT, LORI, The Convergent Participation Model...etc) while covering main aspects in evolution, they enables all reviewers to evaluate all elements without paying attention to their specialization, so the results might be not accurate enough, that beside their general criteria, hence it was the motivations of this study; determining the authentication of each reviewer and offering more specific evaluation criteria. Hence, the proposed research model will known as Learning Objects Reusability Effectiveness Metric

As for the first point, the proposed system in this study is distinguishing between six types of reviewers categorized in three groups; 1. Academic Group (Subject Expert Matter "SME" & Instructor). 2. Technical Group (Instructional Designer "ID", LO Developer & LO Designer). 3. Students group: this group consists of students only.

Regarding evaluations criteria, after literature review and conducting meeting with the professional in education filed we formed the criteria below, evaluation method is differentiated from category to another; most of categories are rating scale consisting of five levels, one other category is check box and the last type of categories is "3 choices radio buttons". Every criterion in the rating scale has minimum acceptable value, when reviewer assigns less value; he/she gets notification message asking him/her to leave comments and suggestions.

i. Re-tasking and Repurposing

Re-tasking; where the LO is used as it is but in another context for objectives other than the objectives which LO is created for, while in Repurposing; some changes are done to the LO to be used in another context for other objectives. If the LO is qualified for repurposing logically it would be qualified for retasking too. Below are 8 characteristics should be found in LO to can be repurposed.

Evaluation Criteria: Rating scale consisting of 5 levels for each element. This category has 6 evaluation points; everyone is evaluated by specific reviewers; 1. Self-contained: it shouldn't depend on any technical or educational object to work effectively. (Reviewers; SME, Instructor & ID, Minimum Rating Scale "5"; in this context

we focus on the word “any” of (Palmer & Richardson 2004) as LO may be unable to work because of depending on very simple external object, so the ideal LO should take 5 points to be accepted otherwise reviewer has to mention the needed objects.)2. Date & Time Independent: doesn't depend on special external events. (Reviewers; SME, Instructor & Developer, Minimum Rating Scale "4") 3. Location Independent: doesn't depend on special location to work effectively. (Reviewers; ID, Developer & Designer, Minimum Rating Scale "4") 4. Generic: can be reused in any educational context as is "context free". (Reviewers; SME & Instructor, Minimum Rating Scale "3") 5. Differentiated: can be used for different levels of education (Reviewers; SME, Instructor & ID, Minimum Rating Scale "3") 6. Modifiable: has the possibility to be modified according to its new objectives. (Reviewers; MSE, Instructor & ID, Minimum Rating Scale "3")

ii. Gender

The second evaluated aspect is “Gender”. As there are essential differences in learning between males and females; from the perspective of performance, participation and outcomes (Collins, Kenway and McLeod 2000), we are keen to know whether LO is suitable for one gender more than the other or it's suitable for both.(Evaluation Criteria: Radio buttons with three choices; 1. Males, 2. Females 3. Both, Reviewers; Instructor, ID & Student)

iii. Accessibility

The category “Accessibility” is responsible of determining how it is easy for people even people with disabilities to use the learning object. We divide the disabilities into 3 types; 1. People who have sensory or mobility disabilities. 2. Deaf or hearing-impaired users.3. Blind or visually impaired users .

Evaluation Criteria: Reviewers will determine if the learning object is accessible for people with each type of disabilities or not, if it's accessible, he/she will check a checkbox that would activate a rating list consist of 5 radio buttons. Reviewer will evaluate the accessibility based on the principles of IMS Guidelines for Developing Accessible Learning Applications. Following are guidelines helping reviewers evaluate the “Accessibility”. Every point in this element is evaluated by the suitable reviewers.

- Accessible people who have sensory or mobility disabilities

According to (IMS Guidelines) for Developing Accessible Learning Applications, there have to; 1. Allow for customization based on user preference. 2. Provide equivalent access to auditory and visual content based on user preference. 3. Provide compatibility with assistive technologies and include complete keyboard access. 4. Provide context and orientation information. 5. Follow IMS specifications and other relevant specifications, standards, and/or guidelines. 6. Consider the use of XML. (Reviewers; Instructor, ID, Developer & Student, Minimum Rating Scale "3")

- Accessible to deaf or hearing-impaired users

At this point reviewer evaluate how learning object is providing access to auditory aspects learning technologies to be accessible for deaf or hearing-impaired users. For LO to be accessible to those with hearing impairments, it should: 1. Caption auditory content. 2. Provide a text transcription of auditory content. (Reviewers; Instructor, ID, Developer & student, Minimum Rating Scale "3")

- Accessible blind or visually impaired users

At this point reviewer evaluate how learning object is providing access to visual aspects of learning technologies to be accessible for blind or visually impaired users. LO should: 1. Has text descriptions (alternative text or alt-text) to all static images (e.g. pictures, logos, charts, links, other graphics) so the text can then be read by a screen reader or output to a Braille display. 2. Has utilization of the "longdesc" attribute for images that have useful content and require more lengthy descriptions. 3. Has an audio description track for multimedia, describing visual aspects of the content. (Reviewers: Instructor, ID, Developer, Designer & student, Minimum Rating Scale "3").

iv. Appropriateness

Evaluation Criteria: Rating scale consisting of 5 levels for each element. This category has only 2 evaluation points; 1. Conformity to its topic (Reviewers: SME, Instructor & ID, Minimum Rating Scale "3"). 2. Suitability to the designed audience (Reviewers; SME, Instructor, ID & Students, Minimum Rating Scale "3"). (Rahman and Tech 2003)

v. Content Quality

Evaluation Criteria: Rating scale consisting of 5 levels for each element. This category has 8 evaluation points; 1. Overall content quality (Reviewers: all reviewers, Minimum Rating Scale "3"). 2. Significant of the learning object topic & appropriate level of details (Reviewers: SME, Instructor & ID, Minimum Rating Scale "3"). 3. Clarity (Reviewers: SME, Instructor, ID & Students, Minimum Rating Scale "3"). 4. Accuracy (Reviewers: SME, Instructor, ID & Students, Minimum Rating Scale "3"). 5. Architecture - in terms of separation of data (Reviewers; SME, Instructor & ID, Minimum Rating Scale "3"). 6. Logics (Reviewers: SME, Instructor, ID & Students, Minimum Rating Scale "3"). 7. Presentation Design (Reviewers; Instructor, ID, Designer, Student, Minimum Rating Scale "3"). 8. Implementation of Interaction Interfaces (Reviewers: Instructor, ID, Developer, Designer and Student, Minimum Rating Scale "3"). (Nesbit and Leacock 2004), (Paulsson and Naeve 2006), (Rahman and Tech 2003)

vi. Metadata

Metadata is data about objects. The purpose of metadata is facilitating several processes like; searching using and evaluating LO, it also facilitates sharing and exchange LOs. (IEEE, 2002), and by the way the reusability of learning object is dependent on the quality of its metadata. (Evaluation Criteria; rating scale consisting of 5 levels).There is one point only in this aspect; Traceable: Learning object should be well identified by suitable metadata, metadata should include; name, explanation, size, order, example, datatype, knowledge objects,

educational objects, knowledge chunks, digital objects and digital educational computer programs. (IEEE Review Committee 2002) & (Nash 2005) (Reviewers: All reviewers, Minimum Rating Scale "4").

vii. Motivation

Evaluation Criteria: Rating scale consisting of 5 levels for each element. This category has 5 evaluation points; 1. Goal achieving: Learning object must meet the goals of students (Reviewers: SME, Instructor & ID, Minimum Rating Scale "4") 2. Proper diffusely: learning object should be neither very difficult nor very easy. (Reviewers: SME, Instructor & Student, Minimum Rating Scale "3") 3. Feedback: Learning object should evaluate the level of learners however this character isn't offered in all learning objects. Reviewers should determine the capability of the LO to do that. (Reviewers: Instructor, ID & Student, Minimum Rating Scale "3") 4. Multimedia and Graphic usage: Learning object is rich in multimedia and graphic that supports its educational goals. (Reviewers: Instructor, ID, Designer & student, Minimum Rating Scale "2") 5. Narration: (lifestyle-homeschool.com) defined it as: "Narration is a technique which at its simplest means 'telling back'. Though in its fullest educational benefit there is more happening than simply comprehension" reviewer should evaluate the effectiveness of narration for the assigned learning object. (Reviewers: Instructor, ID, Designer & student, Minimum Rating Scale "2").

viii. Usability

Evaluation Criteria: Rating scale consisting of 5 levels for each element. This category has 2 evaluation points; 1. Easy of playing/ viewing learning object: Learning object shouldn't need special software or hardware requirements to be used effectively. (Reviewers: Instructor, Developer, Designer & Student, Minimum Rating Scale "4") 2. Ease of use learning object: In this point reviewer should evaluate how it is easy and clear for user to use the learning object. The interface should inform user how to interact with the learning object. (Reviewers: All reviewers, Minimum Rating Scale "4"). Finally author should leave a written comment reflecting his/her feedback about the evaluated LO.

3.1 Case Study Setup

(Frey and Sutton 2010) suggests that learning objects can be multimedia like; animations, assessments, case studies, games, presentations, puzzles, simulations, tutorials, it also can be online course, image, exercise, diagram figure, graph, index, table, narrative, text, exam, experiment, problem, simulation or a book. LORM system is flexible for adding any other types of learning objects materials. In illustrating the case study of this research that would be evaluated, we choose thirteen LOs covers the popular and essential types of LOs.

In this section, we will mention the evaluation of two from the thirteen LOs that evaluated by previous metric to illustrate the different between the previous metrics and the proposed one, and how our proposed metric is more reliable.

Results analysis: MERLOT gives this LO the highest overall rank (five stars) and the same rank for the other three evaluation aspects (content quality, potential effectiveness as a teaching tool and ease of use for both of faculty and students), while LORI gives more specific results as it shows that this learning objects gives feedback to learners, motivate learners, and can be easily used by students with special needs and pointed to that it can be reused in other context by the average 4.1. As for the proposed metric LOREM it gives us more specific results than the other two metrics e.g. LORI pointed out that this learning objects can be used for people with special needs while LOREM clarifies that it can be used for a specific type of learners with special needs as it can be used to hearing-impaired users only, and LORI gives the item usability 4.8, LOREM clarifies that it easier to play or view learning object than using it as the item ease of paying/viewing learning object took 5 points while ease of using took 4.33.

Results analysis: MERLOT gives the full mark to all aspects of evaluation except ease of use takes only 4 stars, while LORI gives more specific results as it deals with fractions, e.g it gives "content quality" 4.2 and "Reusability" 3.2, and give the exact rating to eight items instead of three. LOREM is the only metric that identified the type of learner with special needs that can benefit from this learning object as according to LOREM it can be used by Hearing-Impaired users, As for "content quality" MERLOT gave it five points, LORI 4.2, LOREM 4 points and clarified the mark of every sub-point which make it easy to improve this rate.

IV. FINDINGS DISCUSSION AND DISCUSSIONS

By analyzing and comparing the results of the three metrics, we found that;

Content Quality; giving general rate in MERLOT which represented by stars from one to five, while it's more specific in LORI as it can be represented by fraction, and also taking number from one to five. It's completely specific in LOREM because it's represented by general value to the overall rating of this LO represented by stars from one to five and also includes rating for more eight sub-items (overall content quality, significant of the learning object topic & appropriate level of details, clarity, accuracy, architecture - in terms of separation of data, logics, presentation design, implementation of interaction interfaces) which indicates why it takes this overall rate.

Potential Effectiveness as a Teaching Tool: in MERLOT it's evaluated by stars from one to five, in LORI, this item is included and can be concluded from some points like (learning goal alignment, feedback and adaptation and motivation), while LOREM (for the first time, it evaluates effectiveness from the perspective of gender, evaluate also all of; conformity to its topic, suitability to the designed audience, goal achieving, proper diffusely, feedback, multimedia and graphic usage and narration).

The English Learner Movie Guides

Table 1: Evaluation of LO; the English Learner Movie Guides

MERLOT		LORI		LOREM	
Content Quality	☆☆☆☆☆	Content Quality	4	Gender	Both ★★★★★ Male ★★★★★ Female ★★★★★
		Learning Goal Alignment	4.3	Re-tasking and Repurposing	★★★★★
		Feedback and Adaptation	4.5	Self-contained 4.67 Date and Time Independent 5 Location Independent 5 Generic 4.5 Differentiated 3 Modifiable 4.33	
Potential Effectiveness as a Teaching Tool	☆☆☆☆☆	Motivation	4.8	Accessibility	★★★★★
		Presentation Design	5	Hearing-Impaired users 3	
		Interaction Usability	4.8	Appropriateness	★★★★★
Ease of Use for Both Students and Faculty	☆☆☆☆☆	Accessibility	5	Conformity to its topic 4.33 Suitability to the designed audience 3.75	
		Reusability	4.1	Content Quality ★★★★★ Overall content quality 4.2 Significant of the learning object topic & appropriate level of details 3.67 Clarity 3.75 Accuracy 4.75 Architecture - in terms of separation of data 4 Logics 4.75 Presentation Design 3.5 Implementation of Interaction Interfaces 3.67	
Overall Rating	☆☆☆☆☆	Standards Compliance	4.3	Metadata	★★★★★
		Total Average	4.5	Traceable 4	
				Motivation	★★★★★
				Goal achieving 4.67 Proper diffusely 4.33 Multimedia and Graphic usage 3.33	
				Usability	★★★★★
Easy of playing/ viewing learning object 5 Ease of use learning object 4.33					
Over All	★★★★★				

2. Who Killed William Robinson? Race, Justice...

Table 2: Evaluation of LO; Who Killed William Robinson? Race, Justice...

MERLOT		LORI		LOREM	
Content Quality	☆☆☆☆☆	Content Quality	4.2	Gender	Both ★★★★★ Male ★★★★★ Female ★★★★★
		Learning Goal Alignment	4.3	Retasking & Repurposing	★★★★★
		Feedback and Adaptation	4.8	Self-contained 5 Date & Time Independent 5 Generic 3 Differentiated 5 Modifiable 5	
Potential Effectiveness as a Teaching Tool	☆☆☆☆☆	Motivation	4.2	Accessibility	★★★★★
		Presentation Design	4.5	Hearing-Impaired users 5	
		Interaction Usability	5	Appropriateness	★★★★★
Ease of Use for Both Students and Faculty	☆☆☆☆☆	Accessibility	4.5	Conformity to its topic 5 Suitability to the designed audience 5	
		Reusability	3.2	Content Quality ★★★★★ Overall content quality 4 Significant of the learning object topic & appropriate level of details 5 Clarity 4 Accuracy 5 Architecture - in terms of separation of data 4 Logics 5 Presentation Design 5 Implementation of Interaction Interfaces 5	
Overall Rating	☆☆☆☆☆	Standards Compliance	3	Metadata	★★★★★
		Total Average	4.2	Traceable 5	
				Motivation	★★★★★
				Goal achieving 4 Proper diffusely 5 Feedback 4 Multimedia and Graphic usage 5 Narration 5	
				Usability	★★★★★
Easy of playing/ viewing learning object 5 Ease of use learning object 5					
Over All	★★★★★				

Ease of use for both students and faculty: represented by stars from one to five, LORI used the item accessibility instead of usability to know how it's easy for learner with special needs to access this LO. LOREM separated between usability than accessibility and dealt with every one as a whole category including sub-items, accessibility including evaluation to three types of learners with special needs; people who have sensory or mobility disabilities, deaf or hearing-impaired users, blind or visually impaired users,

while usability including sub-items; easy of playing/ viewing learning object and ease of use learning object

V. SUGGESTIONS FOR FUTURE RESEARCH

However E-Learning is still a new field, we expect that it will be widely used in most of educational organizations soon and of course it can be good opportunity for further research.

In LOREM user can chose learning object according to subject, type, author, target audience age. In future work we suggest modification in this system to enable user to choose learning objects according to the result; the result for the learning object at all and the detailed result for every panel.

VI. Conclusion

LOREM is an advanced step in LOs evaluation systems as it supports users with detailed reliable evaluation to the learning object so it plays essential role in decision making as LOREM is providing clear image about the capability of reusing LO from several perspectives.

LOREM is expected to get the most accurate and reliable results as it allows every member in the team of LOs creation to evaluate only his/ her specific area avoiding to any kind of inexactitude may caused in case of reviewing other areas of specialization as it classifies reviewers into three categories; academic, technical and students as well as classifying evaluation elements into eight category; Retasking& Repurposing, Gender, Accessibility, Appropriateness, Content Quality, Metadata, Motivation, Usability

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