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Characteristics Analysis for Technology Enhanced Learning Maturity: A Qualitative Approach

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Abstract: IT advancement allowed us to experience technology enhanced learning (TEL). However, a learner should implement TEL gradually, following a maturity roadmap, by paying attention to TEL characteristics. TEL covers an extensive discussion embedded in hundreds of research articles. Thus, this research explores the TEL key terms from 12 research digital libraries using the Significant Words approach, postulated by Luhn. The 65 key terms were then analyzed to conceive TEL characteristics. There are nine characteristics for TEL maturity, discussing TEL coverage in facilitating formal-informal learning and various alternatives of learning methods, applying state-of-art technology along with social media and learning management system, and also improving the learning experience and the learning environment to enable self-directed learning. This result may become a foundation to formulate TEL maturity measures.

Keywords: Luhn significant words, maturity measurement, technology enhanced learning, TEL characteristics, TEL key terms

1. Introduction

The shifting of the learning paradigm follows the supporting technology advancement. However, digital discrepancy and learner's capability to utilize the technology are topics of concern. Thus, we need to comprehend ways of using state-of-art technology gradually, which is described as technology enhanced learning maturity (Rahmah, Santoso, & Hasibuan, 2017). Learners should understand the concerning characteristics in implementing TEL with its progression, to comprehend the maturity of TEL implementation. Maturity roadmap follows the shifting paradigm with ubiquitous and seamless learning as the highest level (Ogata & Uosaki, 2012) (Milrad et al., 2013),

This research tries to identify these characteristics by exploiting the key terms of TEL, using the significant words approach (Luhn, 1958) from a massive number of research articles on TEL. Introduced in text analysis research, this method explains that medium frequency words become significant words due to their discriminating power, meanwhile common and rare words are insignificant (Luhn, 1958). The significant words are the ones located in between the upper-cut and lower cut in the Zipf law distribution. The interesting poin is there is no defined principle on how to choose the lower and upper-cut. Van Rijsbergen (1979) stated that it requires a certain amount of arbitrariness. The resulting key terms are not yet in the form of characteristics. We determine the meaning and context using vocabulary control theory to formulate the TEL maturity characteristics.

2. Methodology

The methodology consists of data collection, pre-processing, processing, extracting significant words, and analyzing TEL characteristics. At first, we collect, filter, and choose full-accessed 548 research articles based on the search query "technology enhanced learning" found on the article's title, abstract, or keywords. The contributions are limited to proceedings, journals, and book chapters articles, published after 2010 in 12 accessible research digital libraries. Then, we run data cleaning by

eliminating the article's metadata, punctuation, non-alphabetical words, one-letter words, and stop-words. We also run the lemmatization procedure, parse the words to generate bigram and trigram, and continue with terms frequency of occurrence counting and descending sorting. Bigram and trigram are the chosen format because they can deliver meaning, without having to put in a context.

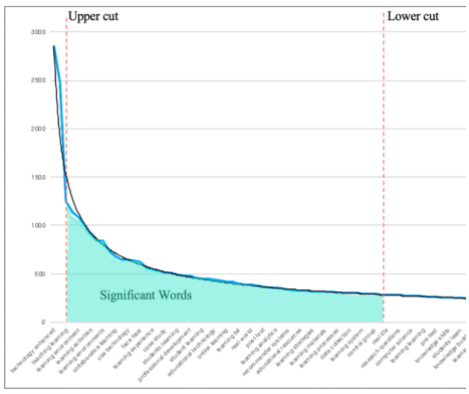

Figure 1. Luhn Distribution

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THE KEY TERMS

advanced learning technologies
blended learning
case study
cognitive load
collaborative learning
computer based learning
computer supported collaborative
control group
data collection
decision making
design based research
design process
educational resources
educational technology
formal informal learning
high school students
higher education
higher education institutions
informal learning
information communication technologies
inquiry based learning
instructional design
interactive learning environments
learning activities
learning analytics
learning design
learning environment
learning experience
learning higher education
learning management system
learning materials
learning objects
learning outcomes
learning process
learning resources
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Figure 2. The Resulting Key Terms

In the following activity, we map the terms into Zipf distribution, delivered in Figure 1. The upper and lower cuts are chosen with prudence. The upper-cut lies on the slope with a significant jump, meanwhile the lower-cut lies before the slope become insignificant. We follow the principle that the number of to-be listed significant words are not too few or too many. It is too many if there are many generic terms with no discriminating power. It is too narrow, for example, less than 20 are not adequate to cover the scope of discussion. We then check for the resulting significant words for their eligibility, of which each term has meaning and relevance to the topic.

3. Result and Discussion

There are 65 important terms, which consist of 29 bigrams, and 36 trigrams (as shown in Figure 2). We formulate the characteristics using facet analysis and thesaurus to structure the filtered terms, comprehend their meaning, and acquire the underlying knowledge. Figure 6 delivers the sample data presentation[1]. Then, we formulate the TEL characteristics for maturity measurement candidates.

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FACETED KEY TERMS

LEGEND
(R) significant words | (C) conceptualization result

TECHNOLOGY
    (R) information communication technologies (ICT)
        (C) Technology trend
            (R) mobile devices
            (R) web based
            (R) social media
LEARNING
    (C) Learning situation
        (R) informal learning
        (R) formal informal learning
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THESAURUS FOR KEY TERMS

LEGEND
BT: broader term | NT: narrower term
RT: related term | USE: use for

Mobile Learning
       BT:  Online Learning
       RT:  Educational Technology
       NT:  Mobile Seamless Learning System

       USE: M-learning
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Figure 3. Example of Faceted Key Terms and Thesaurus

The first characteristic (C1) is about the learning situation, formal and informal. It is based on facet analysis on terms: formal, informal, and both. We define the second characteristic (C2) discussing to what extent technology facilitate online learning, starting from simple web-based learning to full-online learning (without face to face). It is based on the trait in supporting learning with online resources. The key terms are blended learning and web-based learning.

The third(C3) discusses how sophisticated technological trends are applied to support learning. The key terms discuss web technology for learning and mobile learning. Both are associated with the

[1] Complete list can be accessed in http://bit.ly/tel-keyterms

learning shifting paradigm. However, ubiquitous and seamless learning have not yet entered the significant words list. However, we can interpret it as a prospect to pursue. The other key terms are about social media, interpreted as to what extent social media can improve the learning process (C4).

Characteristics (C5) and (C6) take learning methods and drivers as a viewpoint. C5 covers the key terms consisting of collaborative learning, inquiry-based learning, problem-based learning, project-based learning, and self-directed learning. The last one delivers learner viewpoint. Thus we determine characteristic C6 on to what extent self-directed learning and its affecting traits could be improved TEL.

The seventh characteristic relates to what extent the learning environment configured to improve the learning experience (C7). It is also a concern how the technology could enhance learning environments, in terms of facilitating real-time, real-world context, virtual learning environment, and interactive learning environment (C9). Additionally, there are key terms expressed learning environment in higher education and learning systems, including learning management systems (LMS), open educational resources (OER), and massive open online learning (MOOC). Hence, to what extent the learning system is applied in high education becomes a consideration (C8).

4. Conclusion

This study has extracted key terms using Luhn's Significant Words and conceived the nine TEL characteristics' by analyzing these terms using facet analysis, and thesaurus concept. It then becomes TEL maturity measures candidates. This study attempted to explore characteristics of a concept using a cross-discipline technique, usually used in natural language research. The proposition is that key terms have discriminant power to explain a concept. Therefore, the result may not always suit our common sense. As an example, particular trending technology did not emerge as significant words.

Future research may study this finding in greater depth to formulate characteristics with the TEL maturity leveling systems. The study may continue using other natural language techniques and data interpretation to strengthen the discovery. We can also examine related works which deduce characteristics and affecting factors of TEL maturity. Further, the study may also continue by putting a context to the terms, such as sentiment, to explain how a concept affects TEL maturity.

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