

Validation of Learning Effort Algorithm for Real-Time Non-Interfering Based Diagnostic Technique

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ABSTRACT

The objective of this research is to validate the algorithm of learning effort which is an indicator of a new real-time and non-interfering based diagnostic technique. IC³ Mentor, the adaptive e-learning platform fulfilling the requirements of intelligent tutor system, was applied to 165 university students. The learning records of the subjects who attended IC³ Mentor were converted into Characteristic Learning Effort (CLE) curves through the algorithms of learning effort. By evaluating CLE curves and questionnaire survey reports, the findings indicate that the learning effort algorithm is verified to be an effective real-time and non-interfering diagnostic technique. Furthermore, CLE curve is proven to be an effective user-friendly tool for learners and instructors in diagnosing learning progress under adaptive e-learning context. The CLE curve generated by the algorithm of learning effort is a visualized graphic tool which can be applied in the adaptive e-learning platform of education and industry fields.

Keywords: Adaptive E-Learning, Diagnostic Technique, Learning Effort, Non-Interfering, Real-Time

INTRODUCTION

The level of a learner's expertise influences mental effort directly according to Cognitive Load Theory (CLT). Therefore, many diagnostic techniques of assessing expertise related factors had been developed over past decades. The literature review of past studies on diagnostic techniques of assessing expertise under static

and dynamic conditions was conducted in order to identify the requirements and dimensions of a new dynamic diagnostic technique of assessing expertise in the instructional process of adaptive e-learning. Under adaptive e-learning context a learner's learning condition is required to be assessed in a dynamic, real-time, and non-interfering approach which is not fulfilled by those diagnostic techniques presented in past studies.

Hence, a new diagnostic technique was designed to be suitable for adaptive e-learning

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context by improving the imperfections of previous diagnostic techniques. The concept of efficiency has been used by the previous diagnostic technique of assessing expertise. Two indicators of the efficiency, which are effort and performance, have to be assessed in a dynamic, real-time and non-interfering approach in order to achieve a dynamic, real-time and non-interfering based diagnostic technique. Performance was developed as a qualified indicator for a dynamic, real-time and non-interfering based diagnostic technique, but effort has been an unsolved issue according to past studies.

Based on the algorithm of learning effort developed in the new diagnostic technique (Hsu et al., 2009), both indicators of learning efficiency are assessed in a dynamic, real-time and non-interfering approach. Hence, the purpose of this research is to validate the algorithm of learning effort under adaptive e-learning context in order to verify that it is feasible to diagnose learners' learning effort in a dynamic, real-time, and non-interfering status. An experiment situated adaptive e-learning context was applied on 165 university students in Taiwan. The experimental results were converted into characteristic learning effort curves by the algorithm of learning effort in a dynamic, real-time, and non-interfering approach. The characteristic learning effort curves were evaluated together with the questionnaire survey reports in order to verify the effectiveness of algorithm of learning effort in diagnosing learners' learning progress in terms of the interaction between learning effort and performance.

Characteristic learning effort curve was proved by this research to be an effective and user-friendly tool in diagnosing learners' learning progress. Therefore, both learners and instructors are able to diagnose learning progress in a dynamic, real-time and non-interfering process. It supports the real-time communication between learners and instructors to improve learning.

DIAGNOSTIC TECHNIQUES

Static Diagnostic Techniques

According to CLT, the expertise reversal effect is an interaction between several basic cognitive load effects (split-attention, modality, and worked example effects) and level of expertise (Kalyuga et al., 2003, 2007a). The effect is demonstrated when instructional methods that work well for novice learners have no effects or even adverse effects when learners acquire more expertise. In short, the level of expertise of the learner directly influences cognitive load. Furthermore, CLT inquires interactions between information structures and knowledge of human cognition to determine instructional design (van Merriënboer et al., 2005; Kalyuga, 2006); therefore, an effective instructional design for different instructional contexts should be developed with the consideration of expertise. Hence, the diagnostic techniques are needed to assess the levels of expertise of learners in such a way that cognitive load is taken into account.

A review of past studies on diagnostic techniques of assessing expertise under static conditions is presented in this research. The assessments are taken at a specific stage of instruction instead of being conducted dynamically in the instructional process. The following static diagnostic techniques of assessing expertise are presented.

1. **Instructional Efficiency:** For many practical cases, it is feasible for two people to achieve the same performance levels with devoting different effort levels. Hence, both people have identical performance but expertise might be higher for the person who performs the task with less effort than for the person who devotes substantial effort. Therefore, an appropriate diagnostic technique of expertise should include assessments of mental effort and

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