

(続紙 1)

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論文題目	Personalized Learning Analytics Intervention for Enhancing E-Book-Based Learning (電子書籍を用いた学習支援のための個別化したラーニングアナリティクス介入)		
(論文内容の要旨)			
<p>The application of big data in education has been recognized as a promising research field and used to facilitate other research fields such as learning analytics (LA) and educational data mining (EDM). Accordingly, approaches based on the application of LA and EDM have been widely used to analyze the interaction between students and online learning systems and provide intervention for certain educational contexts. With the increasing popularity of digital technologies and LA techniques, researchers have applied various LA intervention approaches in online learning environments to target at-risk students and to provide effective and timely learning support for students to achieve the desired learning goals, improve course participation, and enhance academic outcomes. However, most of the existing intervention models focused on instructional feedback and lacked providing actionable and interpretable feedback. Moreover, in addition to academic performances, indicative measures of student engagement in online learning are needed to examine the pedagogical impacts of such intervention models on students' academic success in an online learning environment. These measures should be adaptable to the unique challenges of learning in a specified context, such as an online learning environment.</p> <p>To address the issues mentioned above, this thesis showed two exploratory studies for identifying e-book learning indicators that positively affect the students' learning achievements. In the first exploratory study, the author applied data analytic methods using the LA and EDM approaches to identify subgroups of students with various learning patterns utilizing an e-book. The aim of the study was to analyze 113 students' behavioral data while using an e-book for learning support. A clustering approach was employed to identify subgroups of students with different patterns of e-book learning behavior. Moreover, a statistical analysis was performed to investigate the associations between the identified subgroups of students and their learning outcomes from the course. The findings of this study provide educators with opportunities to predict students' learning outcomes by analyzing their online learning behaviors and providing timely intervention for improving their learning experience, which achieves one of the goals of learning analytics as part of precision education. Next, in the second exploratory study, to further understand learners' interactions with the note-taking systems (e.g., e-books), lag sequential analysis (LSA) was applied to analyze 88 learners' e-book behavioral data collected in an online learning environment. Moreover, the difference between higher- and lower-achievement learners in terms of their sequential behaviors of e-book note-taking was revealed and discussed. This study can help educators provide evidence-based educational feedback to learners regarding the identified sequential patterns of e-book note-taking that can be applied as effective</p>			

strategies in online learning.

The identified indicators were then used to design and provide actionable and interpretable feedback through personalized LA intervention that integrates the features of an e-book and a recommendation system. The proposed intervention model applied association rule mining to explore the associative connection between the students' levels of behavioral engagement of each knowledge component (built by the teacher) and their learning achievements in the online learning course. Accordingly, the proposed approach aims at providing students with personalized recommendations of remedial actions as a way of intervention for them to take and strategically engage more in using the e-book and avoid failing the online learning course. To examine the pedagogical impacts of the proposed intervention, a quasi-experimental design was conducted in an Accounting Information System graduate course that implemented an e-book as the tool for teaching and in-, out-of-class learning in the online learning environment. 45 students from one class were regarded as the experimental group and learned with the proposed personalized LA intervention approach, in which they used the e-book and the recommendation system to view online learning materials and receive the personalized recommendation of remedial actions to take and strategically engage more in using the e-book, respectively. On the other hand, 42 students from another class were regarded as the control group and learned without the proposed LA intervention approach in the online learning environment, in which they only used the e-book for viewing the given online learning materials. Students' behavioral engagements in online learning measured by e-book learning logs and their learning achievements in the course were analyzed to better understand the significance of the proposed approach. The experimental results offered pedagogical insights into the formulation of LA intervention approaches in the online learning environments for those higher education institutions which are aiming at practicing LA intervention approaches to support teaching and learning experiences in similar contexts.

(論文審査の結果の要旨)

学習は個人の経験であるため、効果的な教育実践には、より個別化した教育デザインが不可欠である。そこで本研究では、電子書籍を用いた学習者のオンライン学習に関するデータを収集・分析することで授業での学業成績と参与度の向上を支援する「個別化したラーニングアナリティクス介入方法」の開発を行った。具体的に、本研究では、以下の2つの観点から研究を行い、研究成果を得た。

1. 既存のラーニングアナリティクスの介入モデルの多くは、教員への共通のフィードバックに焦点を当てており、学習者への個別化したフィードバックの提供はほとんどされていない。さらに、学業成績に加えて、オンライン学習環境での学習者の学業成績に対する介入モデルの影響を調べるために、学習者のオンライン学習に参与する指標の特定が必要となる。そこで本研究では、まず探索的な研究を実施することで、ラーニングアナリティクスおよびデータマイニングアプローチを利用したデータ分析手法を適用して、電子書籍を利用した様々な学習パターンと指標を特定し、個別化したフィードバックを提供する手法を構築した。
2. 次に、本研究では、特定された指標を使用して、電子書籍と推薦システムの機能を統合するラーニングアナリティクス介入を通じて、個別化したフィードバックを設計・提供した。また、準実験的なデザインを通じて、介入方法の有効性を、オンライン学習環境の学部課程で検証した。あるクラスの45人の学習者は実験グループと見なされ、提案された個別のラーニングアナリティクス介入方法で学習したが、別のクラスの他の42人の学習者は対照グループと見なされ、提案された方法なしで、オンライン学習環境で学習した。その結果、電子書籍を用いたオンライン教育と学習経験を支援するためのラーニングアナリティクス介入方法が学習者の学業成績と参与度の向上に効果があることが明らかになった。

以上をまとめると、本研究は、個別化したラーニングアナリティクスのフィードバックに向けた学習者の潜在的ニーズを把握し、介入方法を設計・構築して、その方法の有効性を検証したものであり、個別化した学習支援システムの構築に関する実践的な研究の結果をまとめたものであり、学術上・実応用上寄与するものである。

よって、本論文は博士（情報学）の学位論文として価値あるものと認める。また、令和5年2月21日、論文内容とそれに関連した事項について試問を行った結果、合格と認めた。なお、本論文は、京都大学学位規程第14条第2項に該当するものと判断し、公表に際しては、当面の間当該論文の全文に代えてその内容を要約したものとすることを認める。

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