Research on Leveraging Learning Analytics to Design Personalized Educational Support in Online Learning Environment

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The purpose of this study is to explore the current practice of data collection regarding students that use secondary online education and to develop a system of data management and utilization for the purpose of deriving plans and tasks for supporting personalized learning.

Chapter One explores and analyzes extant literature on customized education to develop a theoretical framework as well as to assess current online secondary education practices. A number of expert conferences consisted of area-specific expert advisory groups were convened with a view to setting a holistic and appropriate research direction and gathering information on suitable cases of learning analysis. In addition, a focus group interview was conducted to identify the divergent needs of learners, teachers, operators, and the Ministry of Education and the Provincial Office of Education in regard to learning analysis education support services. Further, expert delphi surveys and policy debates were conducted in order to identify issues in secondary-level online education and to devise customized education support plans as well as policy tasks based on learning analytics. Five action items that were derived from the various methodologies are 1) improvement of the legal system to enable utilization of data on student learning, 2) using data to develop customized training support services, 3) improvement of data collection practice, 4) enhancement of contents to support customized training as informed by learning analytics, and 5) using learning analytics to better personalize education support system.

Chapter 2 analyzes literature on current uses of learning analytics and personalized education, laws and systems related to the collection and use of personal information big data, and examples of application of learning analytics. Following implications are discussed based on this study's findings. First, as learning analytics encompasses evaluation and instant feedback of the learning process, prediction and prescription of learning performance, discovery of optimal learning paths and improved efficiency, optimization of learning environments, and support level-specific decision making, it must inform and present specific plans, strategies and tasks to achieve its objectives. Second, learning analytics must take comprehensive and holistic approach across macro (national and regional), meso (institutions) and micro (student) levels. Third, the current practice of collecting data on online education based on learning data models, such as the Edu Graph model of IMS Global, should be assessed and enhanced. Fourth, latest technology should be utilized to enable efficient learning analysis. Further, the unit of analysis should be changed from 'groups' to 'individuals' in all phases of teaching in order to utilize learning analytics for customized education support. Fifth, efforts should be made to better align online secondary education and learning analytics platform with national government agenda.

As for legal codes and systems concerning learning analytics and related collection and utilization of personal information, first, the potential issues of legal and ethical problems that may arise in utilizing the learner's personal data and the importance of training data scientists must be noted given that the learning analytics presupposes the collection of learning data. Second, the concept and scope of personal information should be redefined so that various log data accumulated in the system can be analyzed and utilized to enhance the process of individualized learning. At the same time, the data sovereignty should also be strengthened so that students as owners of their personal information can make their own decisions about whether and how their data are utilized for their benefit. Third, a comprehensive system must be devised to enable the combination, integration, and streamlining of personal information and data.

We studied various cases of learning analytics application in overseas K-12 and higher-level education and drew implications for appropriate objectives and methodologies. First, learning analytics should be used to improve academic performance of students with poor academic record due to the lack of academic opportunities and to prevent them from leaving school system. Second, learning analytics can help understand patterns in learners' learning resource utilization, learning behavior and characteristics, and their relationship with academic outcomes. These information in turn can be utilized to enhance the effectiveness of the curriculum and teaching methods. Third, teachers, by utilizing learning analytics, can better plan and establish personalized study plans and even received suitable support by accumulating and analyzing data on students' learning analytics must contribute to better outcomes of education policy and provide evidence for redesigning classroom learning.

Chapter 3 surveys the current secondary-level online education with a view to identifying methodologies and potential projects for personalized education support. To that end, the background and purpose, operating system and subjects, content and systems, collection and utilization of learning data of learning analytics are examined. We found that online secondary education for each policy program has various backgrounds and purposes to meet the educational needs of regular, out-of-school, and adult students. Open Secondary Schools aim at providing educational opportunities for under-educated adult learners while online classes were offered for students that attend regular schools with limited choice of subjects. Online joint curriculum provides real-time video classes and joint courses for small-scale and advanced subjects whereas remote class systems enabled learning for the physically handicapped students or those with chronic illnesses. There also are e-schools that compensate for student athletes' loss of class and provide learning support for out-of-school adolescents and preschoolers for primary and secondary education diplomas.

The overall online education apparatus revolves around the Korean Education Development Institute in charge of running the overall secondary online education while the Ministry of Education and the Provincial Office of Education provide policy-making and budget support services to schools and educational institutions, teachers and students. These parties play varying roles depending on the nature of involved policy projects.

Secondary-level online education contents are mostly those of Open Secondary Schools and are widely in use. Various elective learning and career related contents are also widely utilized depending on the needs of certain policy programs. Different online learning management systems - Learning Management System (LMS), Leaning Content Management System (LCMS), item management systems, evaluation management system, video class platform - have been deployed to assist phase-specific needs.

The current data collection and utilization practice were classified according to the typology the Edu Graph model of IMS Global adopts and consequently were examined in four areas: learning content, learning activities, operations, learner profiles and career data. Our findings indicate that learning data collected from each online education program are mostly basic log data and different programs use different variable names and structure.

Implications derived from the analysis of the current secondary online education practices are as follows. First, online educational support needs to be personalized depending on the needs and goals of each user. Second, reducing inefficiency that result from running separate operating systems requires full

integration of the online operating systems. Third, the scope and role of utilizing educational contents such as open market must be taken into account in designing personalized online education. Fourth, a radical shift in the perception of types of educational contents is called for so that various approaches, such as video lectures, digital textbooks, and live video classes, can become integral parts. Fifth, new indicators of learning analytics other than basic log information must be defined in order to ensure extraction and utilization of meaningful data. Finally, creative technological integration and application are needed to enable automated learning analytics.

Chapter 4 of this report summarizes the findings from focus group interviews (FGI) that were conducted to identify the expected benefits of and specific demands for customized online education. The interviews were also intended to provide insights into how the 6 online-based secondary education services being promoted by the Digital Education Research Center of Korea Education Development Institute are perceived. In addition, the results of the expert delphi survey are summarized for the purpose of devising practical plans and tasks for implementing online education services customization based on learning analytics. The 20 subjects of the FGIs include officials from the Ministry of Education and the Provincial Office of Education, as well as staff, teachers, and students from the institutions that use online secondary education services. The expert delphi survey was conducted in two stages with a total of 20 experts from relevant institutions, academia and industry. Our findings of the FGIs and expert delphi survey are as follows.

First, a shift in overall perception toward online education services is necessary. The emphasis must be placed on achieving practical educational effectiveness rather than the current role of supplementing regular school education or expanding educational opportunities. To this end, new education contents and methods must facilitate teacher-student as well as student-student interaction and encompass measures of evaluation as appropriate for each curriculum.

Second, from the legal and institutional standpoint, relevant legal codes and

systems must be swiftly amended to keep pace with changes in the online education environment. An active and open vision to provide students with practical help must be combined with strict enforcement of privacy protection and copyrights in development and utilization of online education content. Prevention of personal data breach requires higher level of ethics regarding personal information among policy stakeholders as well as more stringent legal and institutional regulations.

Third, the diagnosis of academic capability and learning patterns must be made at the level of individual students rather than groups (e.g., Open Secondary School students, students with health issues, and student athletes, etc.). A motivating environment that facilitates self-regulated learning will provide students with career exploration and education.

Fourth, diverse and effective utilization of online resources such as the development of modular content will necessitate utilizing of data on learners' use of content. Modular content will need to reflect information about the hierarchy and relationships of content as well as students' usage (e.g., indicating segments most repeatedly played by the top 1% of students).

Fifth, exerts are needed for effective use of the learning analytics. Systematic collection, management and utilization of both structured and unstructured data will be required in order to derive meaningful analytical results from policy programs. In addition, Learning Management System (LMS) and learning analytics platforms must be standardized for interoperability.

Chapter 5 presents plans for learning analytics-based personalized online education support in five areas. The plans for each area are summarized below.

The first concerns modifications in the legal codes and systems for collecting and utilizing learning data. First of all, a shift is needed in the personal information and data utilization paradigm such that an emphasis is placed on "safe utilization" instead of "protection." In this context, personal information should be redefined based on identifiability along with a principle as to how to treat learning data as unidentifiable 'behavioral information,' separate from personal

information. The most important thing in the collection and utilization of the learning data is to ensure that users of online education as owners of their information are informed and thus sufficiently aware of exactly what educational benefits can be gained from data analysis as well as potential side effects including possible ethical problems. Additionally, students must be allowed to opt out of data use at any time. In other words, students must be notified of learner profiling in advance and allowed to refuse profiling. To be more specific, we may consider introducing MyData platform as a system that enables learners to control and utilize their personal information and data for their own learning and using it as a basis for the establishment of a broader learning data integration and utilization system.

The second plan is utilizing learning analytics for a personalized education support service. In this study, we identify five areas of online education where personalized training support services can be particularly useful: 1) identifying and providing support for students of potential academic underachievement, 2) preventing school drop-out, 3) tracking the level of participation in online learning, 4) providing customized learning plans, and 5) measuring and comparing student performance. In addition, we propose detailed customized education support services for each online education policy program.

The third plan concerns how to improve the collection of data to allow for learning analytics. We analyzed the current practice of learning data collection per each online education policy program and indicated areas with a room for improvement. Across all policy programs, collection and utilization of students' online learning experience is essential, and a detailed plan for using learning analytics to provide personalized education support is presented for each policy program.

The fourth plan deals with improving educational contents based on the learning analytics to support customized education. First, in order to foster more interactive learning, we propose a new instructional design in the aspects of students-instructional material, student-instructor, student-student interaction from learning analytics point of view. In addition, we emphasize the importance of making accurate 'diagnose' based on learning analytics in personalized education support and along with it, present the need for development of evaluative indicators. Further, we propose plans to modularize educational content in order to expand the quality of the contents to support customized education as well as plans to secure and develop educational contents to support general education.

Last plan concerns a system improvement to support customized education based on learning analytics. The plans for system improvement are presented separately for 2) information system and 2) teaching and learning support system. First, the improvement plan as an information system addresses capacity expansion and changes in database structure to enable big data analysis, data structure for rapid big data analysis and timely service, analysis algorithms, computing performance, automated learning analytics through AI and machine learning, and building a privacy system. The plan for system improvement as a teaching and learning support system deals with expandability to accommodate a future-oriented learning environment, creating synergy between and co-evolution of learning analysis, learning management system and content management system, as well as the need for innovative improvements in visualized user interfaces including the design and development of dashboard.

Chapter 6 identify core principles of online education policy necessary for successful implementation of personalized education support through leveraging learning analytics and propose an implementation road map. Policy suggestions are largely divided into addressing limitations and problems of online education, creating an environment for application of the learning analysis in online education, and promoting continued research on learning analytics.

In terms of improving the limitations and problems of online education, we propose a policy shift to emphasize the quality of online education, a shift in the perception of educational content, and the integration of online educational operating systems. In terms of education quality, diverse instructional methods can

be integrated, and appropriate student evaluation measures for online education need to be devised in ways that value students' actual academic achievements. A shift in the perception toward online educational calls for a break away from negative stereotypes about traditional e-learning formats primarily in the form of video contents. That is, online education contents can be provide in many different forms including video-based teaching materials. The plan to integrate program-specific online education operating systems aim at providing more inclusive online education by creating a more flexible, unified operating system. In terms of creating an environment that allow for application of learning analytics in online education, we propose ways to ease restrictions on the collection and utilization of personal information, to create an integrated system that enable data linkage from a learning analytics perspective, to produce learning analytics experts, and to establish a system for creating and sharing sustainable educational content. Finally, to address the needs for continued research on learning analytics, we propose to establish a learning analytics system as informed by teaching and learning theory, take a thorough inventory of currently disaggregated system resources, and to conduct research to lead the trend of technological development in the area.