

Adoption and Adaptation of Open Educational Resources: Models of Decision-Making and Action Planning

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ABSTRACT

Open educational resources (OER) make educational resources widely available to all students and educators for free. However, OER are still untried by the majority of instructors in higher education. In higher education, an adoption of OER usually involves adaptation activities to make the adopted OER useable in the specific teaching context. This paper applies multiple criteria decision-making (MCDM) approaches to OER adoption and adaptation, and proposes a two-procedure framework of OER adoption decision-making and OER adaptation action planning that can be used to guide OER adoption. The OER adoption decision-making procedure supports OER adoption decision making by using a decision matrix for evaluation of the OER product based on the OER profile and the usability. The adaptation action planning procedure supports the OER adaptation process through generating a plan of OER adaptation for a successful adoption. A case study is used to explain the usefulness of the OER adoption and adaptation framework in higher education.

Keywords: Open educational resources (OER), multiple criteria decision-making (MCDM), adoption of OER, adaptation of OER, higher education, decision matrix, actions matrix

Adopción y adaptación de recursos educativos abiertos: Modelos de toma de decisiones y planificación de acciones

RESUMEN

Los recursos educativos abiertos (REA) hacen que los recursos educativos estén ampliamente disponibles para todos los estudiantes y educadores de forma gratuita. Sin embargo, la mayoría de los profesores de educación superior aún no han probado los REA.

En la educación superior, la adopción de REA generalmente implica actividades de adaptación para hacer que los REA adoptados sean utilizables en el contexto de enseñanza específico. Este documento aplica enfoques de toma de decisiones de múltiples criterios (MCDM) para la adopción y adaptación de REA, y propone un marco de dos procedimientos para la toma de decisiones de adopción de REA y la planificación de acciones de adaptación de REA que se puede utilizar para guiar las adopciones de REA. El procedimiento de toma de decisiones de adopción de REA respalda la toma de decisiones de adopción de REA mediante el uso de una matriz de decisiones para la evaluación del producto de REA basada en el perfil de REA y la usabilidad. El procedimiento de planificación de la acción de adaptación apoya el proceso de adaptación de REA mediante la generación de un plan de adaptación de REA para una adopción exitosa. Se utiliza un estudio de caso para explicar la utilidad del marco de adopción y adaptación de REA en la educación superior.

Palabras clave: Recursos educativos abiertos (REA), toma de decisiones con múltiples criterios (MCDM), adopción de REA, adaptación de REA, educación superior, matriz de decisión, matriz de acciones

开放教育资源的采纳和改编：决策和行动规划模型

摘要

开放教育资源（OER）将教育资源以免费的形式广泛提供给所有学生和教育者。不过，高等教育中绝大多数教师仍然未尝试过OER。采纳OER通常涉及一系列内容改编，以期让改编后的OER在特定教学情境下具有可用性。本文对OER的采纳和改编使用多准则决策法（MCDM），并提出一个包含两个步骤（即OER采纳决策和OER改编行动规划）的框架，该框架能被用于指导OER采纳。在OER采纳决策步骤中，基于OER的信息描述和可用性，使用决策矩阵评价OER产品，进而支持OER采纳决策。在OER改编行动规划步骤中，通过创造能被成功采纳的OER改编计划，进而支持OER改编过程。使用了一项案例研究解释OER采纳和改编框架在高等教育中的有用性。

关键词：开放教育资源（OER），多准则决策（MCDM），OER采纳，OER改编，高等教育，决策矩阵，行动矩阵

Introduction

Open educational resources (OER) (OER Commons, 2020; MIT OpenCourseWare, 2020) represent an innovative movement in education and are growing in awareness and use during the past decade. OER can make educational resources widely available to all students and educators for free. However, OER have not been significantly adopted in the higher education sector (Kortemeyer, 2013; Allen & Seaman, 2014; Wang, 2018).

OER include diversified forms of educational materials such as books, audio and visual artifacts, lecture series, and articles. Originally, OER aim to reduce prices of textbooks in higher education (Hilton & Wiley, 2011). After years of OER development, the financial sustainability of OER in higher education remains under debate (Downes, 2011; Joyner, 2013; Annand, 2015). To address the problem of OER sustainability, research papers have proposed business models for OER (e.g., Downes, 2007; de Langen, 2013). In fact, the business models of effective financially sustainable OER in higher education involve many stakeholders at several levels of society, education institutions, the OER community, and individual faculty members. Sustainable OER can be achieved only when OER create, deliver, and capture measurable values for students, education institutions, OER developers, and the entire society (Wang, 2019).

Challenges for OER in the higher education sector are more significant than those in the K-12 education

or community college sectors. Higher education concentrates on specialization of diversified disciplines, and promotes research and academic freedom. In addition, there are few consistent codes of ethics related to the issues of textbooks in higher education (Robie et al., 2003). Nevertheless, while the financial sustainability of OER in higher education remains to be seen, OER researchers in higher education (Colvard et al., 2018) have claimed that OER do much more than simply save students money and address student debt concerns, and can improve end-of-course grades at significant rates. Undoubtedly, if OER have about the same quality and about the same adoption process as commercialized educational resources, there is no reason for instructors not to adopt OER. The reality is that not every discipline in higher education can find OER which can compete with commercialized education resources in all aspects of quality, teaching instruments, and academic services. Accordingly, an adoption of OER usually requires an extensive adaptation process to modify adopted OER or to create supplemental materials based on the specific teaching context. When an academic unit or an individual faculty member chooses to use OER to replace the commercialized educational materials, they must search the target OER, make an adoption decision, generate an adaptation plan, and complete an adaptation process. This paper is to propose an OER adoption decision-making procedure to support OER adoption decisions and an OER adaptation planning procedure to support adaptation actions processes. It

applies a case study to demonstrate the usefulness of the tools.

The rest of this article is organized as follows: a) Issues of OER in Higher Education; b) OER Adoption Decision-Making Procedure; c) OER Adaptation Action Planning Procedure; d) A Case Study of OER Textbook Adoption and Adaptation; e) Discussion and Contribution; and f) Conclusion of the study.

Adoption and Adaptation of Open Educational Resources: Models of Decision-Making and Action Planning

This section discusses the issues of OER in higher education that characterize the weaknesses of current OER and the difficulties faced by OER adopters in higher education.

Limitations of the model of production of OER in higher education

OER are generated by two major sources. One source of OER is sponsorships of governments, charity organizations, and educational institutions. Those OER sponsors provide financial support and hire developers to generate OER. The other source of OER is voluntary teams or individuals who license their own educational materials as OER. Currently, most, if not all, OER are produced by using a stand-alone project approach (Wang & Wang, 2016). A stand-alone project has a start point and a clear finish line. After the finish

line, when the project deliverables are delivered, the project sponsorship is terminated and the team is dissolved. This stand-alone model of OER production has limitations because OER are knowledge products and need to be continuously updated or improved. Apparently, as the stand-alone project approach does not support OER updating and improvement, massive OER have quickly become “waste” that are waiting for recycling. Although OER can be modified to reuse by anyone, coordination of piece-meal style updating is difficult in the OER environment. As a result, significant volume of OER in the cloud has been antiquated that in turn, makes search of usable OER difficult. Furthermore, stand-alone projects do not emphasize long-term academic services for the OER. On the competitors’ side, commercial publishers have the advantage of editorial staff to make fast revisions (Zinser & Brunswick, 2010), to provide updated materials, as well as value-added services to both instructors and students.

Not many higher education institutions formally recognize faculties’ contributions to OER

As a knowledge intensive society, higher education institutions expect faculties to create new knowledge (Mohrman et al., 2008). Accordingly, basic scientific research has been the dominant element in the academic reward systems in higher education (Serow, 2000). Although few higher educational institutions would oppose OER, not many institutions have clear policies

of rewards beyond moral support for OER development or OER adoption. The motivation for faculty members to develop OER or OER adoption without tangible rewards is highly doubtful. A challenge for OER in higher education is to achieve some success in preserving or expanding the place of effective OER development and OER adoption in the reward systems at higher educational institutions.

Lack of practical solutions to sustainable OER in higher education

Autonomy is one of the unique characteristics in higher educational institutions that distinguishes it from other types of organizations (Bentley & Kyvik, 2011). The autonomy in higher education is present at the organizational level (Enders et al., 2013), as well as the individual level (Hoecht, 2006). The autonomy in higher education is meant to protect academic freedom and to promote self-governance within the academic institutions (Kreysing, 2002). On the other hand, OER involve many types of stakeholders (Wang & Wang, 2018), and the OER movement is determined by the diversified social and political factors. Currently, there are few effective practical solutions to wide OER diffusion in the autonomic environment of higher education. Although the OER community continuously seeks effective solutions to sustainable OER, the sustainability of OER without continuous project funding support in higher education has not yet been fully achieved (Wang, 2019). A significant

challenge for OER in higher education is to develop a practical framework to achieve sustainable OER in the autonomic environment.

Methodology

Multiple Criteria Decision-Making (MCDM)

OER adoption raises a variety of concerns, including curriculum compliance, worth of invested time and effort, risks of failure, and others. Concerns vary, and depend upon institutional strategies, characteristics of disciplines, career stages of faculty members, and others (Wang, 2021). Faculty's confidence at the planning phase of an OER adoption project is represented in the result of a decision-making process. This section explains how various factors involved in the decision-making process in OER adoption projects, and provides a systematic approach to evaluation of OER adoption projects.

OER adoption and adaptation are multiple criteria decision-making (MCDM) problems (Acuna-Soto, Liern, & Perez-Gladish, 2019). MCDM is a multi-disciplinary methodology for decision-making and scenario planning (Zeleny, 1973; Zionts, 1979; Hwang & Yoon, K. 1981). MCDM supports structuring complex problems through specifying multiple criteria explicitly and leads to more informed and better decisions. There have been a variety of methods and tools in MCDM developed in an array of the contexts of decision-making analysis since the start of

the research subject in the early 1960s. Decision matrix (Shafer, 1976; Yang & Singh, 1994) is a widely-applied MCDM tool. A decision matrix is a list of values in rows and columns that allows an analyst to systematically identify, analyze, and rate the relationships between these values. The elements of a decision matrix include certain decision factors (or decision criteria) and their properties and perceived performance in the decision-making context. The matrix is used to present the decision factors and assessment of each factor's relative significance for a decision-making problem.

OER adoption decision-making

There are two categories of factors that can influence people in OER adoption decision making: OER profile and OER usability for a particular course.

Factors of OER profile:

The profile of an OER product describes the major characteristics of the OER product and provides a general outline of the OER product. A profile of OER product does not portray the quality of contents which depends on specific target course and the adopter's subjective judgement. The major factors of profile of OER product and their definitions are listed below.

- Creator credential: Creator's academic background
- Organization affiliation: Reputation of the "host" organization
- Authenticity: Free of plagiarism or forgery
- Sponsorship: Reputation of the sponsors if any

- Copyright and licenses: Type of Creative Commons Licenses
- Language: The language used
- Currency: Publication date
- Reviews: Peer review records
- Social network: User community
- Accessibility: Accessible to people with disabilities
- Special requirements: Any special equipment other than normal computers is needed.

The factors of OER profile are evaluated by objective facts. Usually, a decision of adoption is based on the facts of whether the OER profile meets certain criteria. For example, an OER product published longer than a decade ago without properly updating is considered obsolete.

Factors of OER usability for the target course:

The usability of an OER product depend upon the context of use for a particular course. In comparison with the factors of OER profile, the factors of OER usability are evaluated by subjective measurements. The major factors of OER usability and their definitions are listed below.

- Alignment to course objectives: Alignment to the target course objectives
- Valid contents: The contents are valid and current, and appropriate for the target audience
- Clarity of presentation: The contents are presented clearly and logically
- Quality of teaching instruments:

The quality of teaching instruments (e.g., PowerPoint slides)

- Quality of teaching manual: The quality of teaching instructions
- Quality of assignment materials: The quality of materials or instructions of assignments (e.g., exercises, projects, lab, survey, etc.) for students
- Quality of assessment instruments: The quality of assessment instruments (e.g., quiz tests, exams, discussion questions, etc.)
- Fitness to the technological environment: The condition of being suitable for the technological platform (e.g., online learning management system).

Each of the OER usability factors may not be equally important to the target course. To incorporate the relative importance of each factor in the evaluation, the weighted average method can be used. This method assigns a relative importance weight (e.g., a 0.1-1 scale) to each usability factor. The adopter then rates the OER product with respect to each usability factor and obtains the rating (e.g., a 0-1 scale) of each of the usability factors. The rating value of each usability factor is multiplied by the corresponding importance weight to calculate a weighted score. These weighted scores are then summed over all the factors to obtain one aggregate weighted score for the OER product. The aggregate weighted score is considered the usability measure of the OER product for the target course. The weighted average method

is simple, but has its limitation in that the weights and the ratings of usability factors are subjective.

The decision matrix is a simple instrument for selection of OER products for the target course. A decision matrix is a table of decision factors and values that allows the OER adopters to systematically identify, analyze, and rate the OER profile factors and OER usability factors. In the present case, a decision matrix includes two parts: OER profile evaluation and OER usability evaluation, as shown in Table 1.

OER adaptation action planning

Adoptions of OER can be different from adoptions of commercial educational resources in two aspects. First, currently, few OER products have complete ancillary materials for teaching, such as teaching manuals, test banks, and assignment materials, and adopters of OER need to perform certain “self-services” which would otherwise be provided by commercial publishers (Wang & Wang, 2017). Second, on the positive side, OER can be modified by anyone to meet particular needs in the specific context of course. Thus, a full adoption of OER for a course would include adaptation actions.

An action plan delineates the actions needed to reach a goal. In this study, an OER adaptation action plan guides how the adopted OER can be used for the target course through modification and further development of ancillary teaching materials. Using an action plan matrix, one can list the adaptation actions after the selection of

the OER product, and specify the benefits, potential issues, estimated workload, and suggestions for each action.

Table 2 exhibits a template of OER adaptation actions matrix.

Table 1. Decision Matrix of OER Adoption

OER Profile			
Profile Factors		Property of the OER Product	Pass/Failure
Creator credential			
Organization affiliation			
Authenticity			
Sponsorship			
Copyright and licenses			
Language			
Currency			
Reviews			
Social network			
Accessibility			
Special requirements			
OER Usability			
Usability Factors		Rating	Weight
Alignment to course objectives			
Valid contents			
Clarity of presentation			
Quality of teaching instruments			
Quality of teaching manual			
Quality of assignment materials			
Quality of assessment instruments			
Fitness to the technological environment			
Total Weighted Average Score			

Table 2. OER Adaptation Actions Matrix

Actions	Benefits	Potential Issues	Estimated Workload	Suggestions
Action-1				
Action-2				
.....				

A Case Study of OER Textbook Adoption and Adaptation

The proposed models of decision making and action planning for OER textbook adoption and adaption are pragmatic. While rigorous peer review plus long-term examination is unfilled, a case study seems to be the only feasible tool to validate the proposed models. this section presents a case study of OER textbook adoption and adaptation in higher education, and demonstrates the process of OER adoption decision making and OER adaptation action planning.

The course selected in the case study was the Introduction to Information Systems, a business core course for all undergraduate business majors. The commercial textbook used in this course before the OER adoption costs more than \$150 USD. The case study was to answer a general question: what is the process of full-scale adoption of OER for a course by replacing the commercial textbook with an OER textbook?

(1) Preliminary search for OER textbooks for the course to replace the commercial textbook

The first phase of an OER adoption was to search the candidate OER textbooks. Keywords related to the course title were used to search the popular OER web portals as well as the Internet in general. The review work in this case study was not difficult because the number of available OER textbooks for the course is not large, and only three

OER textbooks related to this course were found.

(2) Decision of selection of an OER textbook for the course

A selection decision making process was conducted to compare the three alternatives. OER adoption decision matrices were applied to evaluate each of the three alternatives. Only Bourgeois' textbook (2019) passed the OER profile evaluation. The OER usability evaluation was then conducted. The decision matrix for the OER textbook is exhibited in Table 3. As indicated in Table 3, in terms of the topics covered and the contents, this open access textbook was not significantly different from the commercial textbook currently used for the course. Hence, the difference between the OER textbook and the replaced commercial textbook was not considered a factor for the teaching and learning effectiveness of the course.

Ancillary materials of a textbook are important for instructors because they can assist the instructors for preparations and teaching. The OER textbook does not publish with its ancillary teaching materials. However, the website of the OER textbook posted useful teaching instruments for the previous version of the textbook, such as PowerPoint lecture slides and assessment instruments, developed by adopters of this OER textbook in several higher educational institutions. In this example, this OER textbook had above the average usability of OER textbooks in this aspect. Nevertheless, the ancillary materials of this OER textbook

posted on the website or other places were not as complete as that of the replaced commercial textbook. To make the OER textbook more usable for the present course to meet the designed

learning objectives, adaptation actions to develop additional ancillary materials for this OER textbook seemed to be necessary.

Table 3. Decision Matrix of OER Adoption in the Case Study

OER Profile		
Profile Factors	Property of the OER Product	Pass/Failure
Creator credential	The author holds PhD in the academic field	Pass
Organization affiliation	The university is accredited by the WASC Senior College and University Commission (USA)	Pass
Authenticity	The original version was published in 2014 and was licensed under Creative Commons Attribution-NonCommercial 4.0 International License	Pass
Sponsorship	The original 2014 version was funded by the Saylor Foundation	Pass
Copyright and licenses	Licensed under Creative Commons Attribution-NonCommercial 4.0 International License	Pass
Language	English	Pass
Currency	Revised from the 2014 version	Pass
Reviews	The OER textbook website shows numerous users of the textbook. Several scholars in the field have contributed to the revision of the 2014 edition	Pass
Social network	A strong social network https://opentextbook.site/	Pass
Accessibility	PDF and Web versions	Pass
Special requirements	No	Pass
OER Usability		
Usability Factors	Rating	Weight
Alignment to course objectives	1	1
Valid contents	1	1
Clarity of presentation	1	1
Quality of teaching instruments	1	0.8
Quality of teaching manual	0.1	0.2
Quality of assignment materials	0.5	1
Quality of assessment instruments	0.5	0.5
Fitness to the technological environment	1	0.5
Total Weight Average Score	5.07 (of 6)	

(3) Adaptation actions

There are a few sets of PowerPoint lecture slides for the previous version of the OER textbook posted on the OER textbook's website. To meet the needs of the present course, these PowerPoint lecture slides were modified.

Student self-assessment using OER is one of the many distinctive features of OER. However, student self-assessment may not be sufficient in the higher education environment, and summative assessment is commonly applied to measure the level of competency of students. The use of all genuine OER materials introduces an issue for summative assessment in higher education because assessment instruments could be open to every student. The issues of academic integrity and educational ethics related to summative assessment in the OER environment have not been widely discussed in the literature. Few services of protected test banks for OER textbooks are available. As the adoption of the OER textbook was not intended to make fundamental changes to the summative assessment scheme and no protected test bank for the adopted OER textbook was available, a set of proprietary assessment instruments, including quiz tests and assignments (e.g., essay topics and discussion questions) was needed for the course.

The course in the present case study required a technical module of computer literacy (e.g., Microsoft Access and/or Excel). The OER textbook did not have companion materials of such a technical module, and a set of teaching and learning instruments for

the technical module of computer literacy was needed for the course.

Nowadays, learning management systems (LMS) are used for all on-line, face-to-face, and blended courses. Implementation of all teaching and assessment materials on LMS is a natural step of full-scale adoption of OER for a course. In this case study, the course had its existing LMS course site before the adoption. Nevertheless, in this case, teaching materials had to be manually inputted into the LMS because of a lack of tools of conversion for incompatible formats. The adaptation actions are summarised in Table 4.

(4) Assessment of student learning outcomes

To evaluate the student learning outcomes in the course with full-scale adoption of OER with adaptation actions, assessment of the OER adoption must be conducted. In the present case study, two data sets were collected from four comparable classes of this course: two classes with the commercial textbook and two classes with OER. The assessment criteria (rubrics) used for evaluating students' learning outcomes of discussions, technical assignments, and course reports in the four classes were the same. Four assessment categories were applied: quiz tests to assess reading, technical assignments to assess technical skills developed through the course, discussions to assess class participation and knowledge sharing, and course reports to assess managerial applications of the concepts. The following is a summary of assessment for the

Table 4. OER Adaptation Actions Matrix in the Case Study

Actions	Benefits	Potential Issues	Estimated Workload	Suggestions
1. Modification of OER PowerPoint lecture slides for the previous version available on the Internet	The PowerPoint lecture slides would meet the course needs and to be consistent with the new version	Need to obtain a permission if the posted PowerPoint lecture slides are not OER	20 hours	A teaching assistant could do this task
2. Modification and creation of a set of discussion questions	The discussion questions would be more suitable for the course	None	8 hours	A teaching assistant could help
3. Creation of a set of proprietary quiz tests	Academic integrity and ethics would be maintained	The test bank needs to be secured	60 hours	Two sets might be needed
4. Creation of a set of teaching module of technical assignment	The teaching module of technical assignment would improve students' learning of the textbook as well as computer literacy	The teaching module must be comparable with the university's computing resources	120 hours	A complete set of teaching note, instructions, and assessment instruments for this module are needed
5. Implementation of a course site with all adopted and adapted materials on the Learning Management System	The course could be taught online	The course site is subject to the university's online development and instruction rules	32 hours	Collaboration with university's online development and instruction team is needed

case of OER textbook adoption and adaptation.

- Quiz test results: Students of the classes with OER and students of the classes with the commercial textbook have almost the same performance on quiz tests.
- Quality of technical assignments: Students of the classes with OER and students of the classes with the commercial textbook have almost the same performance on technical assignments.

- Quality of online discussions: Students of the classes with OER can have better performance on discussions than students of the classes with the commercial textbook.
- Quality of course reports: Students of the classes with OER and students of the classes with the commercial textbook have almost the same performance on course reports.

Clearly, the assessment data indicated that the full-scaled adoption and adaptation of OER textbook could

achieve at least the same level of student learning as the commercial textbook did in this course. To understand more about students' subjective opinions on the OER teaching/learning materials and their confidence of learning, surveys were conducted. The survey results revealed the students' overwhelmingly positive attitude towards OER teaching and learning materials and a high level of confidence in learning. The surveys also indicated that textbook cost saving was not a critical factor for students in making decisions of course/section selection, and the quality of OER textbook and its supplemental teaching materials were students' main concern.

Discussion and Contribution

Currently, OER adoption in higher education is still relying on "self-services", and, in comparison with adoption of commercial textbooks, an adoption of OER still demands much more work on the instructors' side for adaptation processes. On the other hand, few general tools have reported in the literature of OER for guiding OER adoption decision making and OER adaptation action planning. The proposed tools can be used for instructors to make decisions in OER adoption and to plan OER adaptation actions. This study contributes to OER in two aspects. First, the

adoption decision making procedure and adaptation planning procedure can be applied to any disciplines in higher education for OER adoption. The proposed OER adoption framework can be used for academic units and individual instructors. Second, the study suggests that OER developers and their sponsors can use these tools to estimate the value of their OER products and can provide guidelines for the potential adopters of their OER products.

Conclusion

The adoption and adaptation of OER textbooks are facing many challenges in the higher education sector. A successful adoption of OER to meet the designed learning objectives of the course demands more intellectual work on the instructors' side in comparison with of the adoption of a commercial textbook. The adopting instructors of OER need to perform certain self-services of adaptation that were otherwise provided by the commercial publishers. This study proposes tools of OER adoption decision making and OER adaptation planning. The case study demonstrates the use of the proposed tools. This study concludes that the proposal OER adoption and adaptation tools are useful for all educational institutions and individual faculty members to act for sustainable OER.

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