# Challenges and Opportunities for Open Educational Resources in Higher Mathematics Education

**Abstract.** Open Educational Resources (OERs) can overcome barriers in higher mathematics education through cost reduction, increased accessibility, and adaptable materials for teachers. The purpose of this paper is to provide a deeper understanding of the need for OERs in higher mathematics education, as well as the potential for collaboration and readiness for their use in Estonia. OERs can benefit teaching and learning in various ways. The adoption and utilization of OERs in Estonia is limited. The authors conducted an online survey with mathematics teachers from different universities and institutions to investigate the reasons for the absence of OERs, the necessity of a digital library of OERs, and the willingness to cooperate in its creation and use. The survey results showed that most respondents considered the digital library necessary and were ready to collaborate in various forms, such as creating, testing, reviewing, and translating materials. However, some respondents were reluctant to share their materials for free or did not find the digital library useful for their specific courses. In conclusion, collaboration in the development of OERs would help overcome the barriers and challenges associated with OERs in higher mathematics education in Estonia.

**Keywords:** OER Digital Library in Mathematics, Cooperation in Higher Education in Mathematics.

## 1 Introduction

Open Educational Resources (OERs) have the potential to alleviate barriers to learning in higher mathematics education by reducing costs, increasing accessibility, and enabling the adaptation of educational materials to the needs of teachers [1].

OERs are learning, teaching and research materials in any format and medium that reside in the public domain or are under copyright that have been released under an open license, that permit no-cost access, re-use, re-purpose, adaptation and redistribution by others [2].

Estonia is a small country located on the eastern coast of the Baltic Sea, the fourth from the end populous country in the European Union. Despite OERs widespread use worldwide for over 20 years, the adoption and utilization of OERs in higher mathematics education in Estonia is still limited and Estonian higher education currently lacks governmental initiatives and interest in supporting the creation and implementation of OERs [3].

To address this issue, many countries and international initiatives have developed strategies and policies to promote the use of OERs in education [4]. Therefore, it is important for educators and policymakers in Estonia to recognize the benefits of OERs and take steps toward their wider adoption in higher mathematics education.

However, the adoption and utilization of OERs in higher mathematics education in Estonia is still limited. Therefore, it is important to examine the current state of

readiness and opportunities for collaboration in the development of OERs in mathematics education in Estonia.

The purpose of this paper is to provide a deeper understanding of the need for OERs in higher mathematics education, as well as the potential for collaboration and readiness for their use in Estonia. Also, article aims to investigate the reasons for the absence of OER mathematical materials in higher education in Estonia, according to the perspectives of current teachers. By examining the opportunities and challenges associated with OERs, educators and policymakers can develop effective strategies to promote their use in higher mathematics education, ultimately improving access to education and leading to better student outcomes. In light of the above described, an international Erasmus+ project Gate2Math, the aim of this project is to create a smart multilingual library of OERs in the field of mathematics for high-level education, has been established to facilitate the creation and development of OERs, thereby aiming to enhance the current situation and ensure sustainability in the field of OER, especially in Estonia.

## 2 Background

Digital educational resources are a priority of Estonian educational policy, as coordinated by the Ministry of Education and Research in accordance with the Lifelong Learning Strategy for 2014-2020 [5] and the Estonian Education Strategy 2021-2035 [6]. The three strategic goals of the latter are: (1) diverse and accessible learning opportunities, and an education system that ensures a smooth transition between levels and types of education; (2) competent and motivated teachers and directors, a diverse learning environment, and a student-centered approach to learning and teaching; (3) the relevance of training options to the needs of the development of society and the labor market. It should be noted that openness is not the main reason for focusing on digital educational resources.

The OER infrastructure in Estonia consists of educational object repositories, educational resource development tools, evaluation platforms, virtual learning environments (VLE), and auxiliary systems such as metadata application profile and single sign-on (SSO) [3]. The concept of learning objects arose in Estonia in connection with e-learning support programs such as BeSt program (for universities, lasting from 2008-2013), VANKeR (for vocational education institutions and universities of applied sciences, lasting from 2008-2013), e-Jump, e-VÕTI and Primus (lasting from 2008-2015, financed from European structural funds and implemented by the Archimedes Foundation). The goal of this last program was to support the quality of higher education and increase the competitiveness of graduates, and to fulfill the goals, it worked closely with 23 partners, including 19 higher education institutions.

A learning object is defined as a complete digital resource that can be reused in different learning contexts and support learning, but changing them may not be possible due to copyright or design considerations. The most common types of e-learning objects in Estonia are animation, audio lectures, presentations, exercises (tasks), training videos, simulators, content packages (short courses), dictionaries, tests, and video lecture/multimedia synopses. Thus, the idea of learning objects (LO)

is similar in nature to the idea of open educational resources (OER). Both LO and OER are types of digital educational resources that have associated metadata, including digital rights and learning design information such as learning goals and context.

Founded in 2016 under the auspices of the Ministry of Education and Research, the e-Koolikott (e-Schoolbag) platform presently serves as a repository for over 18,700 educational resources. These resources encompass a wide range of materials, including open source resources, unlicensed resources, and select commercial content. Educators are afforded the opportunity to curate content collections utilizing existing resources while also incorporating their own material into the repository. A significant proportion of the resources available on the platform were created using interactive H5P templates as part of the national Open Educational Resources (OER) initiative known as the "Digital Learning Property" project (DigiÕppeVaramu, 2017-2018). This project entailed the collaborative efforts of Tallinn University and resulted in the production of over 10,000 interactive educational objects. Rigorous quality control measures were implemented, and the materials underwent extensive testing by teachers from 30 schools. The materials on the e-Koolikott platform are freely accessible and editable by all teachers and students [3]. Learning objects can be annotated, recommended, and combined into shared collections, with optional login functionality facilitated through Estonian national authentication methods. Ministry of Education and Research, in conjunction with the European Social Fund, has allocated funding for initiatives aimed at developing digital OER specifically tailored to students with special needs. These projects prioritize the creation of simplified teaching aids, workbooks, worksheets, and other instructional materials. Furthermore, various projects and communities have independently established their own open source repositories. Notable examples include KAE Kool, which hosts over 150 educational videos licensed under the Creative Commons Attribution-NonCommercial-ShareAlike (CC BY-NC-SA) license. Additionally, a physics-themed repository has been collaboratively developed by Project Tiger Leap, the University of Tartu, the Institute of Physics of the University of Tartu, and Ministry of Education and Research. Teachers also employ standard office software and Web 2.0 tools in conjunction with platforms such as Weebly, Blogger, WordPress, and Google Sites to create open educational resources. These resources often integrate external materials sourced from platforms such as YouTube, SlideShare, LearningApps, and Geogebra.

In higher and professional education, the repository of educational objects operated by the Foundation for Information Technology for Education (HITSA) went live in 2009 [HITSA]. Less than 5% of the resources on the platform are unassociated with any funded content development project. The repository contains over 4,600 learning resources, all licensed under a Creative Commons license as required by the projects. The main purpose of this repository was to store resources that were developed in various content development projects funded by the European Social Fund. Põldoja and Laanpere [3] note that after the end of financial support for content development, the growth of the repository has decreased significantly. As a result of the reorganization of tasks between foundations operating in the educational field, the repository of the HITSA Innovation Center has not been available to users since July 1, 2020. All materials in the eLearning repository will be archived until the end of

2025. Now, in the field of higher education, there are currently no initiatives at the state level to support the development and implementation of OER. Materials created for higher education are now stored in institutional repositories. The digital archive DSpace is mostly used as a repository, containing educational material, learning objects, and educational videos prepared by the teaching staff of higher and professional educational institutions. Access to the content of the digital archive is guaranteed to all interested parties through the user interface and API (Application Programming Interface) standards. DSpace content is publicly available for both download and reuse, except in exceptional cases where the work is closed, restricted, or embargoed. All file formats are accepted for the preservation of publications and databases. The amount of data that can be stored in DSpace is unlimited. The main virtual learning environment used in vocational and higher education in Estonia is Moodle, which also stores OERs created during various projects; for example, materials created within the international project "EngiMath - Mathematics on-line learning model in Engineering education" (2018-2021, 2018-1-EE01-KA203-047098).

Analyzing the situation of OER in higher education, Põldoja and Laanpere [3] conclude that although there are lecturers who use open licenses and have created web pages for their OER, for the most part, higher education teachers are skeptical about the adoption of OER and are not ready to share their resources in repositories. The authors believe that this is due to the general lack of awareness of OER and open licenses.

## 3 Methods and Results

The collection of data was carried out using an online survey consisting of 11 questions. The survey comprised close-ended questions, but there was always an option to provide additional information. The survey consisted of questions about the need for a digital library, reasons why it is missing, willingness to create it in a collaborative way, and by whom it could be used.

The survey was compiled using a Google Form and conducted in spring 2023. The survey was distributed to mathematics teachers in universities and universities of applied sciences through personal contacts or the universities' academic affairs units.

Despite the fact that Estonia has a population of only 1.33 million, it has over 15 different higher education institutions, which can be divided into 3 main groups: public comprehensive universities, public specialized universities and private universities and institutes. Two universities train mathematicians and teachers of mathematics, so they represent more different branches of mathematics. Basically, specialized higher educational institutions teach the basics of mathematical analysis and algebra; statistics and economic mathematics are also very popular. However, some schools do not offer mathematical courses at all. It is very difficult to count the exact number of mathematics teachers in higher education institutions, since their number may fluctuate depending on the period of the year and since some teachers work simultaneously in two or three different educational institutions.

33 responses were received from mathematics teachers from different universities and institutions: 8 from both TalTech and Tallinn University, 7 from Tartu University,

4 from Estonian University of Life Sciences and TTK University of Applied Sciences, and 1 each from Estonian Entrepreneurship University of Applied Sciences and Tallinn Health Care College. These respondents represent 5 major areas of mathematics: algebra and geometry, discrete mathematics, mathematical analysis, probability theory and mathematical statistics, and applied mathematics.

First, the survey investigated the reasons for the absence of a digital library in higher education in the field of mathematics (see Table 1).

**Table 1.** The reasons for the absence of a digital library.

| Reasons | Number of responses |
|---|---|
| Lack of government support | 18 |
| There are many specific subjects taught by one or two teachers | 14 |
| Reluctance to share educational materials for free | 12 |
| There is a shortage of mathematicians | 10 |
| Do not want to share my own property or that of the university | 8 |
| Everyone has sufficient study materials of their own | 8 |
| Foreign OER digital collections are used | 2 |
| In mathematics, it is not possible to properly digitize study materials | 2 |
| I use my university's collection of study materials | 2 |
| A general digital collection does not make sense | 2 |
| There is a lack of people for developing such a digital collection | 1 |
| There is a preference for developing of university's LMS | 1 |

The most commonly cited reason was the lack of government support (including platform, funding, and administrator). This response option was chosen by 18 respondents. The next most important response options were the abundance of subject-specific courses taught by only one or two teachers (14 responses), reluctance to share teaching materials for free (12 responses), and a shortage of mathematicians (10 responses). 8 respondents believed that the reasons were reluctance to share their own or university property and having sufficient teaching materials.

24 respondents acknowledged the necessity of a digital library, while 9 respondents stated that such a thing is not needed. Out of those nine, five named the main reason as everyone having sufficient teaching materials of their own. One of the reasons for this attitude again lies in the size of the country and the number of educational institutions. It is rare to find the same specialty in different educational institutions, and if it is, most likely there are different learning objectives, different requirements for admission and graduation, and different levels of student skill. Accordingly, mathematics is likely taught differently in these different institutions. Therefore, there are few universal educational materials in mathematics, and those that there are often altered by teachers for their students and for the specifics of the subject.

The respondents were informed that we are developing such a digital repository and asked them which volunteer activities they would be willing to contribute to. 24 respondents agreed to cooperate in the development of a digital library. The responses were divided as follows: providing error feedback (12 responses), testing materials (11 responses), creating materials (9 responses), reviewing materials (9 responses), involving learners to collaborate (6 responses), and translating materials (4 responses). Out of the nine individuals who did not consider the digital library necessary, four of them are nonetheless willing to contribute to its creation for free. Two of them are willing to contribute by translating materials, and two by reporting errors.

Those who were not willing to contribute to the creation of a free digital library were asked to justify their response. The main reasons given were lack of time (6 respondents), their specific approach to teaching the subject, which may not be suitable for another teachers (4 respondents), willingness to contribute only for a fee (3 respondents), and contribution to the development of their university's digital repository (2 respondents).

Next, the survey asked about the readiness to use such a digital library. 27 people were ready and 6 were not ready to use it. 30 respondents would recommend using this digital library for learners, whereas 3 would not. Four respondents justified their refusal by stating that the learning materials made by others do not align with their teaching logic, and one respondent mentioned already having sufficient materials.

## 4 Discussion and Conclusion

In conclusion, the findings of this study provide valuable insights into the topic of OER in the field of mathematics in Estonia. The survey reveals that most respondents suppose the absence of an OER in higher mathematics in Estonia is due to a lack of state funding, specific courses only being taught by a few lecturers, and a reluctance to share materials for free. Põldoja and Laanpere [3] also pointed to a link between the lack of financial support and the lack of open educational materials.

The study showed that teachers consider the existence of such a library necessary.

Additionally, the results of the survey indicate a significant willingness of the majority of respondents to cooperate. The study showed that educators are open to various forms of collaboration, including creating materials and testing content developed by other colleagues. Notably, even teachers who do not consider the library necessary expressed their willingness to contribute to its establishment. The majority of teachers expressed a desire to use the library when it is available, and even more recommend it to their students. The authors attribute the limited willingness to share existing materials with the skepticism of teachers towards open educational materials; the same fact is emphasized by Põldoja and Laanpere [3].

Reasons for teacher reluctance to cooperate include lack of time and teachers' specific approaches to teaching a subject that may not be suitable for others.

However, the authors believed that collaboration in the creation of OERs would help mitigate the aforementioned barriers in the field, including the issue of faculty overload, which is a significant concern in higher education.

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