



Impact of the Integration of OERs on Learning Outcomes: Case of Engineering Students in Morocco

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Abstract. This paper attempts to assess the impact of integrating Open Educational Resources (OERs) on the learning outcomes of the finance course taught to students of a Moroccan engineering school. For that purpose, an event methodology is used to compare students' learning outcomes before the use of OERs (i.e., in 2019) and after by tracking grades of three cohorts (2020, 2021, and 2022). The parent population of the four cohorts includes 1,194 students. The paper also investigates the combined effect of using OERs and changing the mode of instruction (face-to-face and emergency distance education).

Overall, the results show that OERs use is associated with a rise in student grades, primarily when the course is delivered remotely and recorded, allowing for self-paced learning.

Keywords: Open Educational Resources · Knowledge economy · Learning economy · Learning outcomes · Higher education

1 Introduction

Education is a key means to ensure countries' competitiveness and sustainable development after the shift to a new post-industrial economic model based mainly on knowledge, called "knowledge economy". Therefore, the education system is under increased pressure to prepare the future workforce to meet the new skill requirements of tomorrow's jobs (WEF, 2020) demanded by Industry 4.0 and 5.0. In this context, knowledge becomes obsolete faster than before, requiring the workforce to easily adapt to new changes through self-learning, skilling and even reskilling.

The education system is a greater contributor to the economy than ever before because the new economic model is based on the "consumer of knowledge" and primarily on the "producer of knowledge" through innovation, which education must encourage.

OERs are a fundamental way of producing knowledge and ensuring its accessibility at any time and place for all, free of charge, with the right to reuse it, modify it, adapt it to meet the needs of users and redistribute it. Thus, access to knowledge is available to both non-schooling and schooling learners. Learning becomes in fact a common good. Thus, OER reinforces the globalization of education, which is a global citizenship right.

OERs are a curricular innovation that has the potential to address the challenges of education at different levels (kindergarten, primary, secondary and tertiary). OERs have

been widely accepted by policy makers since 2002 and several initiatives have emerged at the local, regional and national levels. These include the Policies for OERs Uptake (POERUP), the European Open Education Policy Project, and the Creative Commons OERs Policy Registry.

The learning economy is an essential component of the knowledge economy coined by Lundvall. In the learning economy, the ability to learn is responsible for the relative position of individuals, firms and national systems and for the sustainable development of the economy as a whole.

In fact, the OERs movement has been successful in ensuring the accessibility of educational material, hence many research studies have wondered whether adoption of OERs improves student learning outcomes. Results are mix and show positive effect (Hilton and Laman, 2012; Grimaldi et al., 2019; Orr and van Damme, 2015) and mostly null effects (Allen et al. (2015), Lawrence and Lester (2018), Mi Choi and Carpenter (2017)). Grimaldi et al. (2019) argue that OERs integration has no effect on students' exam grades because they just make the traditional textbook content accessible for all students without necessarily improving its quality. However, Orr and van Damme (2015) give three explanations for the positive effect of OERs noticed on learning outcomes: (i) harnessing the possibilities afforded by digital technology mainly productivity tools; (ii) allowing a new form of interaction between teachers and learners that fosters innovation; (iii) possibility for teachers and learners to adapt, alter and distribute the content, thus extending the life cycle of the original content.

This paper aims to assess the impact of OERs integration in 2020 within the Finance course provided to the first-year engineering students of a Moroccan school. In this regard, it would be relevant to study the exam grade evolution of four cohorts (2019–2022) including 1,194 students according to an event methodology. Worth noting that the integration of OERs is a voluntary initiative that occurred within the framework of curriculum innovation that led to a pedagogical architecture change. During the studied period the mode of learning has shifted from face-to-face in 2019, to emergency remote learning for two years (2020–2021), to finally return in 2022 to face-to-face. The study attempts to neutralize the effect of the change of mode of learning in order to assess properly the effect of the integration of OERs on learning outcomes measured by exam grades. Moreover, it investigates the combined effect of using OERs and changing the mode of instruction. It is worth mentioning that the school used to offer the course material to all students.

The pedagogical architecture of finance course based on OERs enables to foster students' interaction and involvement. In fact, the use of OERs before class followed by a formative assessment enables students to acquire a prior knowledge that will be developed and discussed in class, which makes the development of new knowledge easier according to Piaget (1971). This participatory approach aims to empower students and develop their critical thinking. These are the main skills needed for the job of the future by the WEF (WEF, 2020). The course architecture also adopts a constructivist approach as it is built in blocks with the students' participation and the guided monitoring of the teacher (OERs-quiz). The course uses real cases to promote experience which might affect students' learning outcomes and foster their motivation and involvement specially because this pragmatic course aims to develop real-life skills, which is related to Dewey's approach. In this case, OERs serve actually, Education for Sustainable Development (ESD).

In order to assess the impact of integrating OERs into the Finance course provided to engineering students, this paper will discuss the OERs definition before presenting an overview of the literature review on OERs and learning outcomes. Then, it will present the methodology of the study and finally discuss the findings.

2 OERs Definition

The term “open educational resources” was coined in 2002 at the UNESCO Forum on the Impact of Open Courseware for Higher Education in Developing Countries. It refers to all types of research and educational resources used for learning and teaching that are in the public domain with a copyleft or copyright under open license allowing free use and in principle re-purposing to the own need of users (Atkins, Brown, & Hammond’s, 2007). They are wholly or partially accessible free of charge, anywhere and anytime, through ICT for non-commercial purposes (UNESCO 2002, p.24). OERs include Open Access (OA) research and data basis, videos, podcasts, lectures, corrected exercises, free homework help, textbooks, books, journals, dictionaries, and free software with customization options. In practice ‘open content’ also called ‘open source’ is a copyrightable work that is licensed for free with or without *commercial restrictions* and *creating derivatives*.

According to Marshall (2009, p. 89), OERs have three main characteristics: (i) *Free, anytime, anywhere access* to content and software, accessible only to those with passwords and proprietary rights; (ii) *Use* of content with or without restrictions when downloading, duplicating, and distributing; and (iii) *Reuse of content* to adapt it to serve users own needs with or without restrictions. Wiley (2013) outlines four main characteristics known as Willey’s four Rs, namely *Reuse* the content in diverse manners (in class, in MOOCs, on website, etc.), *Revise* (the right to alter the original content), *Remix* (the right to combine several contents original or revised to create a new content and even to translate), and *Redistribute* (the right to share the original content or revised one). Bliss and Smith (2022) add a fifth feature, *Retain* (the right to store and make a copy of the content).

These OERs characteristics ensure knowledge materials’ openness and sharing for. In general, OERs are designed with diverse learners in mind and enable self-paced learning for non-schooling learners and enrolled students in kindergarten, primary, secondary and tertiary education. Moreover, the right to reuse, revise and remix permit a perpetual re-creation and knowledge expansion. Therefore, OERs promote the globalization of education, the development of the knowledge economy and society, and contribute significantly to education for sustainable development and countries’ competitiveness.

3 OERs and Learning Outcomes: An Overview of Literature Review

Research on OERs tackles basically two topics. First, the effect of the openness and free cost OERs material on reducing the dropout rate in comparison to the textbook material that are more and more expensive mainly for low-income countries. Thus, these researches assess the extent to which OERs improve accessibility for learning and ensure equality for knowledge and education for all which is a fundamental human right for

global citizenship. In general, they use a study case at a school or university level (Santos-Hermosa, Ferrán-Ferrer, & Abadal, 2013; Smith, 2013) or at the institutional level to assess the impact and efficacy educational policies adopting OERs, namely financial and academic benefits for students and institutions using primarily cost- effectiveness (Bliss, Hilton, Wiley, & Thanos, 2013; Wiley, Hilton, Ellington, & Hall, 2012, Chiorescu, 2017).

Second, other studies aim to assess and understand the effect of OERs on learning outcomes. They compare student grades with OERs and traditional textbooks. Results are mixed and most studies found no effects. Some studies found a positive effect in exam grades and lower dropout rate (Hilton and Laman, 2012; Grimaldi et al., 2019; Orr and van Damme, 2015) claim that OERs positively impact educational processes. Orr and van Damme (2015) provide three reasons to this evidence: (i) harnessing the possibilities afforded by digital technology; (ii) allowing a new form of interaction between teachers and learners that foster innovation; (iii) possibility for teachers and learners to adapt, alter and distribute the content what prolonged the life cycle of the original content.

However, many studies have found no meaningful grades difference between OERs and traditional textbooks (Allen et al. (2015), Lawrence and Lester (2018), Mi Choi and Carpenter (2017)). While other studies found contradictory results for the same study. Lovett et al. (2008) found no substantial difference in the results of regular examinations, but did find a positive effect of adopting OERs on the results of a specialized examination. Robinson (2015) found a negative effect of OERs in two classes, and no significant difference in the other five classes. Across fifteen courses, Fischer et al. (2015) found a negative effect of OERs in one course, a positive effect of OERs in five courses, and a non-significant difference in the remaining nine courses. These controversial results might owe to research quality and rigor that failed sometimes to control confounding variables (Grimaldi et al. (2019)). Additionally, to study the effect of OERs on learning outcomes student classes should have the same rate of access, otherwise, results will be biased by the improvement of grades due to the increase in the students' accessibility of learning materials.

The lack of OERs effect on grades largely found is not surprising because the main purpose of OERs is to ensure the accessibility of the traditional textbook content to all students in free and open license, which does not imply any improvement in quality (Grimaldi et al. (2019)). Therefore, the course material accessibility is expected to affect the dropout rate but not the quality of learning and apprenticeship. However, the use of ICT can bring a certain well-being in learning in terms of organizing lecture notes allowing for time saving and efficiency, in addition to the advantage of anytime/anywhere availability.

4 Methodology and Basic Population Presentation

4.1 Finance Course and Covid-19 Health Crisis: Educational Innovation and Teaching Mode

This study concerns the Finance course taught to first-year students at the National School of Mines of Rabat (NSMR). The Finance course is a financial education course that focuses on personal and corporate finance.

In 2019, the finance course was a traditional higher education course with lectures and tutorials. In 2020 the OERs are integrated as a voluntary initiative, the first one at the school. It is carried out within the framework of an active and participatory educational innovation to empower students and involve them more in the learning process by using problem-solving approaches, as well as real-life case studies. The pedagogical architecture of the course is based on ICTE, namely the LMS platform ‘Google Classroom’, Google Forms for quizzes, and open access educational resources such as videos, images and pdf.

Thus, before each class session, the professor makes available on the Google Classroom platform the course syllabus with its OERs, i.e., YouTube videos serving as explanations and/or examples of real-life cases, as well as images and documents. After viewing this educational content, students are invited to take an online quiz before class. This formative assessment is intended to allow students to self-assess their learning. At the end of the quiz, students can see their score, as well as the correct and wrong answers.

The class session is intended for discussion to deepen the content that was consulted by students before class. This pedagogical architecture allows for more interactivity and student involvement. However, its implementation for the first time was marked by low student adherence because it requires a digital device, access to internet, and ICT literacy. These requirements are not within the reach of all students.

In 2020 the Finance course was taught for three sessions in person before switching to distance learning because of COVID-19, requiring general lockdown and therefore the suspension of teaching on campus. Distance learning was provided by audio recordings. Student questions were asked on Google Classroom and answers were provided in audio and on the chat of Google Classroom platform. The audio class recording was the most affordable solution for students as it consumes less internet. Moreover, it can be sent easily by WhatsApp to students who do not have computers. The lecture recording allows students to learn at their own pace. To avoid dropout, the school had offered internet recharges for needy students.

In 2021 the teaching was conducted with the same pedagogical architecture with video conference allowing a synchronized distance learning. No lecture recording was provided to students. To ensure the education inclusion to all students, the school’s management proposed video-conferences on the ARENA platform for which internet access is free and the presence of students is controlled. However, this platform was often not able to support the connection of all students at the same time. Thus, students who had no problem with internet access used Google Meet and the others ARENA. The course was interactive and held in resembling conditions to face-to-face courses. In 2022, the Finance course was delivered in person after the health restrictions were lifted.

4.2 Methodology

The study aims to assess the effect of OERs integration on students’ learning outcomes according to the event methodology comparing the distribution grades of the 2020 cohort subject to the event “OERs integration in finance course” with that of the 2019 pre-event cohort, where instruction was provided without OERs. Finance course examination grades are taken for a proxy of learning outcomes. For more relevancy, the study does

not limit itself to a spot comparison, it rather follows up the evolution grades of the three cohorts that benefited from the OERs, namely 2020, 2021 and 2022.

The difficulty of the study lies in studying the effect of two events in 2020: the integration of OERs and the implementation of emergency distance education.

In order to neutralize the effect of the event ‘teaching mode change’ on the target event ‘integration of OERs’, it would be relevant to compare students’ learning outcomes for the same teaching mode. Thus, it is appropriate to compare the learning outcomes of the following cohorts that lead to addressing the hypotheses below. Moreover, the study also investigates the combined effect of using OERs and changing the mode of teaching.

Classes	Learning characteristics	Aim of the comparison
<ul style="list-style-type: none"> • 2019 • 2022 	<ul style="list-style-type: none"> • face-to-face without OERs • face-to-face with OERs 	<ul style="list-style-type: none"> • verify the impact of OERs; • compare the learning outcomes of a traditional approach to a modern one.
H1.1: The integration of OERs in face-to-face course has a positive impact on students’ learning outcomes		
<ul style="list-style-type: none"> • 2020 • 2021 	<ul style="list-style-type: none"> • distance learning with OERs and recorded audio lecture • distance learning with OERs and without lecture recording 	<ul style="list-style-type: none"> • verify the effect of OERs over time, particularly with the entrenchment of digital literacy in the habits of teachers and students
H1.2: Remote education with OERs positively impacts students’ learning outcomes		
<ul style="list-style-type: none"> • 2019 • 2020 	<ul style="list-style-type: none"> • face-to-face without OERs • distance learning with OERs and recorded audio lecture 	<ul style="list-style-type: none"> • study the combined effect of distance learning and the OERs integration; • test whether distance learning with recorded sessions that allows students to learn at their own pace is responsible for better learning outcomes compared to traditional face-to-face instruction.
H2: Distance learning with OERs and recorded sessions is responsible for better learning outcomes than a traditional course in face-to-face		
<ul style="list-style-type: none"> • 2020–2021 • 2022 	<ul style="list-style-type: none"> • distance learning with OERs • face-to-face with OERs 	<ul style="list-style-type: none"> • Test the effect of returning to face-to-face teaching after two years of distance learning with OERs during which students were free to interact behind a screen without being intimidated by the gaze of others.
H3: Returning to face-to-face instruction negatively impacts students’ learning outcomes		

The results of this study are based on a working assumption that the IQ and learning ability of students of the four cohorts are similar, or even identical, which is not entirely true, although the conditions for selecting engineering students did not change for the four cohorts. For that reason, we should be aware that our conclusions are approximated.

Analysis of the learning outcomes data will mobilize univariate and multivariate descriptive analyses, as well as cross-sectional analysis of trends in grades and pass rates.

4.3 Basic Population Presentation

The study is based on parent population of four cohorts of engineering students (2019–2022) who studied the Finance course scheduled the first year at NSMR. The size of the four cohorts is successively 290, 322, 293, and 289 students (Table 1). Therefore, the size of parent population is 1,194 students. Overall, female students make up more than half of each cohort (between 52% and 58%) (Table 3).

5 Findings and Discussion

The Table 1 shows the Finance course learning outcomes of four cohorts engineering students.

The 2019 cohort that has been taught in a traditional way as per usual in face-to-face with only pdf material course has less learning outcomes than the further cohorts 2020 and 2021. The latter have benefited from OERs, in addition to the usual course material, formative assessments (quizzes), and collaborative LMS platform (Google Classroom).

Session 1 pass rate has jumped from 69% in 2019 to over 90% in 2020 to level off in 2021. In 2022 the session 1 pass rate has substantially declined to 55% with the move back to face-to-face class, in spite of the use of OERs, improved digital literacy and also students' involvement in completing their quizzes. Paradoxically, the integration of OERs and the change in the mode of instruction have no significant impact on the average grades of.

Table 1. Finance course learning outcomes of four cohorts engineering students

	2019	2020	2021	2022
Class size	290	322	293	289
Session 1 pass rate	69%	94%	92%	55%
Session 2* pass rate	89%	100%	90%	69%
Overall pass rate	92%	99%	95%	78%
Average grade session 1	14.13	14.97	13.21	13.05
Average grade session 1 & 2	13.50	12.00	13.16	12.26
Minimum grade	5.00	8.25	8.00	3.00
Maximum grade	19.50	17.50	17.50	18.50
Variance grade	5.82	2.08	1.64	8.00
Standard deviation grade	2.41	1.44	1.28	2.83
Student involvement rate	NA	28%	65%	70%

* Session 2: is the make-up examination session

Table 2. Learning outcomes distribution per grade interval

	2019	2020	2021	2022	TOTAL
Grade < 6	0.7%	0.0%	0.0%	2.1%	0.7%
6 < Grade < 12	7.6%	0.9%	5.1%	20.1%	8.2%
12 < Grade < 14	51.4%	23.0%	71.0%	51.9%	48.7%
14 < Grade < 16	30.7%	70.2%	23.2%	18.3%	36.5%
16 < Grade < 18	8.6%	5.9%	0.7%	7.6%	5.7%
18 < Grade < 20	1.0%	0.0%	0.0%	0.0%	0.3%

the four cohorts. However, the grades’ standard deviation is lower when learning is distance with a score spread from the mean less than 1.5. In face-to-face, the average difference between the grades is almost 3 marks.

In addition, the distribution of exam score structure has largely changed in 2020, as shown in Table 2. The majority (70.2%) of students in the 2020 cohort have scores between 14 and 16 out of 20 while the majority (over 51%) of students in other cohorts have scores between 12 and 14.

Table 3 shows the distribution of learning outcomes by gender. Overall, female students account for more than 50% of those who pass the first session exam in the course of the four years, except in 2020. It should be noted that 12 out of 20 is the threshold grade for passing a subject. However, with less than 12 students can benefit from compensation between modules or redemption by jury points. This is precisely why the sum of the pass rates for female and male students presented in Table 3 does not add up to 100%.

Over the 2019–2021 period, the intra-gender pass rate shows an increase in learning outcomes for both female and male students and a decrease in the gap between them. The latter widened in 2022 in favour of female students (88% for females vs. 64% for males) with a significant decline in learning outcomes.

5.1 The Impact of OERs Integration on Learning Outcomes in Face-to-Face

To study the OERs impact we should neutralize the effect of the teaching mode by comparing cohorts learning outcomes that studied in face-to-face before and after the OERs integration, namely 2019 and 2022 cohorts. The overall pass rate shows a decrease in learning outcomes (-15%) between 2022 and 2019. A substantial decrease concerns male students (-39,16%), unlike female students that learning outcomes have increased about 6,84%. However, they are also concerned by a decrease in grades (almost 1 point mark) and an increase in grades gap as.

shown by the variance and standard deviation (Table 1). It worth to note that 2022 cohort students have been well involved in the use of the digital educational tools as shows the involving rate of students doing their quizzes after consulting the OERs posted on Classroom platform. Moreover, these students have more ease in the use of ICTEs and

Table 3. Learning outcomes distribution by gender

	2019		2020		2021		2022	
	Female	Male	Female	Male	Female	Male	Female	Male
%	52%	48%	48%	52%	53%	47%	58%	42%
Pass rate in Session 1 inter-gender*	53%	39%	47%	52%	51%	45%	58%	24%
Overall Pass rate inter-gender	48%	44%	48%	52%	50%	45%	51%	27%
Pass rate in session 1 intra-gender**	77%	61%	92%	96%	93%	91%	67%	38%
Overall Pass rate intra-gender	93%	91%	98%	100%	95%	95%	88%	64%
Average grade inter-gender	14.45	12.49	14.73	14.93	13.23	13.08	13.16	11.00
Minimum grade inter-gender	5	5.5	8.25	12	8	8.5	4	3
Maximum grade inter-gender	19.5	18.5	17.25	17.5	17.5	17.5	18.5	17.5
Median inter-gender	14.5	12	15.25	15.25	13	13	12.5	12

* This rate refers to students who have more than a passing score of 12 out of 20 divided by the number of students who passed the exam in the first session.

*** This rate refers to students by gender who have more than passing score 12 out of 20 divided by the total number of students of the same gender.

have improve their digital literacy because they have studied two years earlier remotely by using digital educational tools.

It is indeed, difficult to conclude that the integration did not improve learning outcomes or on the contrary reduced it, because the study did not focus ideally on the same students. Moreover, the 2022 cohort students have studied two years in the emergency conditions of health crisis and they likely have learning deficits comparing to the pre-Covid-19 class of 2019. Furthermore, the effect of OERs on learning outcomes is very mixed between female and male students. Therefore, *we cannot accept the H1.1 hypothesis nor affirm a strong rejection*. Mixed results of the impact of OERs on learning outcomes were also reported among others by Lovett et al. (2008); Fischer et al. (2015); and Robinson (2015).

5.2 The Impact of OERs on Learning Outcomes in Remote Education

The best student learning outcomes were achieved when learning was at a distance with OERs course materials. The 2020 results might be due to the fact that students benefited from both the OERs content and the recorded lectures. They were free to play them as many times as they wanted until assimilation. Thus, each student could learn at his

or her own pace. This could be the main reason for the improved learning outcomes since the only difference was that the lectures were not recorded in 2021. In 2021, the course was delivered online via video conferencing through Google Meet and Arena. The sessions were more interactive than face-to-face, perhaps because students felt freer to ask questions behind their laptop screens. As mentioned by Orr and van Damme (2015) students discover a new way of interacting with teachers and with each other. It is worth mentioning a slight decrease in the overall pass rate in 2021 (-4%) by which only male students (-12.61%) are concerned, while an improvement of about 4.87% was particular to female students. On average, a slight decrease in grades occurred in 2021. Hence, 70% of students have grades between 14 and 16 in 2020, and between 12 and 14 in 2021. However, student engagement in taking their quizzes increased sharply from 28% to 65% in 2021. The slight decrease in learning outcomes in 2021 is not a sufficient reason to reject the positive effect of OERs and distance learning on students' learning outcomes. Therefore, *hypothesis H1.2 is accepted*. Furthermore, student learning outcomes cannot be attributed separately to any of these factors.

5.3 Mode of Learning Impact on Learning Outcomes

Distance learning with OERs and recorded courses in 2020 shows an increase in pass rate (by about 37% in session 1 and 8% overall) compared to the traditional method of instruction (2019), namely in face-to-face sessions without OERs. Overall, there is an upward trend in student grades (Table 2). 70% of students have grades between 14 and 16, while in 2019, 50% have grades between 12 and 14. However, in 2019, students have more excellent grades, i.e., above 16 (9.6%) than in 2020 (5.9%). Surprisingly, the learning outcomes of male students increased significantly (17.72%) to the point of surpassing female students whose learning outcomes remained unchanged. Therefore, we can *validate hypothesis H2* which states that distance learning with OERs and recorded sessions is responsible for better learning outcomes than a traditional course in face-to-face considering the success rate of session 1 and the increase in the percentage of students with good grades between 12 and 16 (93.2% in 2020 vs. 82.1%) and the decrease in the percentage of bad grades (0.9% in 2020 vs. 8.3% in 2019).

Overall, the return to face-to-face instruction in 2022 with OERs had a negative effect on learning outcomes compared to the two prior years. However, students' engagement rate has improved significantly. There is a decrease in the pass rate for session 1 by about (-41% on average) and in the overall pass rate, by about (-20%). The decrease among male students is more pronounced (-45%). On the contrary, female students noted an increase in learning outcomes by an average of 20% in session 1 and 5% overall. In addition, students' grades decreased significantly. Poor grades represent 22.2% (vs. 0.9% in 2020), good grades 70.20% (vs. 93.2% in 2020) and excellent grades 7.60% (vs. 5.9% in 2020). We can conclude that the return to face-to-face teaching has a negative impact on students' learning outcomes and therefore *validate hypothesis H3*. This result may be due to the learning deficit of students accumulated under Covid-19 conditions. In this case, this result cannot be generalizable.

6 Conclusion

The study of the effect of OERs integration on engineering students' learning outcomes was conducted using an event-based methodology, first comparing the exam scores of the 2020 cohort to those of the previous cohort that did not benefit from OERs. Then, for more relevance, the evolution of exam scores of three cohorts was tracked after OERs integration. Overall, the results show an increase in learning outcomes when OERs are used, especially when we move from face-to-face to distance learning. Learning outcomes are even higher when the course is recorded, allowing for self-paced learning. A slight decline in learning outcomes is observed in 2021, despite the entrenchment of digital literacy and the obvious improvement in student engagement. However, the outcomes are still higher than a traditional course taught without OER and ICTE. Returning to face-to-face instruction with OERs after two years of emergency distance education had a negative impact on student learning outcomes, perhaps because students accumulated learning deficits during the disrupted period of Covid-19.

However, the impact of integrating OERs with on-campus learning cannot be proven due to the mixed results and likely learning deficit compared to the pre-Covid-19 class of 2019.

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