More than tools: "video lecture capture" as a step towards pedagogic differentiation

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Abstract

Purpose – The present study aims to analyse the presumed relationship between VLC use and students' grades.

Design/methodology/approach – The research strategy unfolds as a case study (Yin, 1994), framed by how undergraduate students of pharmaceutical sciences used video lecture capture (VLC) and the impact of VLC on pedagogic differentiation. Looking at the course of Mechanistic Toxicology (MecTox), the objective is to describe this case of pharmaceutical sciences in depth.

Findings – The findings reveal that over 90% of students engaged with VLC videos, with the average viewing time exceeding the total available video minutes, indicating strong student engagement. The study particularly highlights VLC's positive impact on students with lower academic performance (grades D and E), suggesting that VLC can help reduce the performance gap and support a more inclusive educational environment.

Research limitations/implications – The findings may have limited generalisability beyond the specific context and sample used. However, this study allows the research findings to be compared with previous research (Remião *et al.*, 2022), contributing to the debate on how pedagogic research can promote evidence-based decisions regarding innovative strategies. The meaning of educational inclusion processes and diversity is, thus, contingent on the institutionalisation of research as a practice of teaching and learning.

Practical implications – The results of this study thus provide interesting insights for the design of strategic action, considering the diversity of students as seen in parents' academic qualifications and students' conditions (e.g. student-workers, living away from home, holding a grant of economic and social support).

Social implications – The implications of research findings for society bring the issue of equity in education to the fore. By addressing the diverse needs of students, HEIs can contribute to greater educational equity.

Originality/value – Using VLC as a differentiated pedagogic device might give diversity "real" content insofar as institutional and national policies can mitigate the possible negative effects of parents' low academic qualifications and the students' conditions of living away from their residence area and holding a grant of economic and social support.

Keywords Video lecture capture, Student performance, Inclusion in higher education

Paper type Research paper

Introduction

The digital divide unfairly affects socially and economically vulnerable students by limiting their access to essential technological resources, such as reliable internet connections, up-to-date

devices, and digital literacy training. Video lecture capture (VLC) platforms can offer offline learning resources for students with limited internet access, enabling them to download materials and participate in lessons without needing a continuous connection. By widening participation and ensuring that all students, regardless of their economic or social situation, have access to high-quality educational resources, VLC can play a crucial role in bridging the digital divide and promoting educational equity.

VLC refers to the multimedia recording of live classes before an audience of students and allows lecturers to record their classes and make the videos available digitally. It is a teaching and learning technology tool that can promote student learning (Saunders and Gale, 2012) and can be implemented through image and voice recording of the entire learning environment, including the class, the lecturer (audio and image), visual aids (for example, PowerPoint), and the audience (audio and image), or just some of these elements. Over the last few years, the use of VLC within higher education institutions (HEIs), particularly in the UK, USA, Australia, and Singapore, has markedly increased (Crook and Schofield, 2017; Danielson *et al*., 2014; Edwards and Clinton, 2019; Joseph-Richard *et al*., 2018; MacKay, 2019; Newton *et al*., 2014; Witton, 2017).

Regardless of the approach, a significant increase in the use of VLC in HEIs has been described in recent years, particularly in the United Kingdom, USA, Australia, and Singapore (O'Callaghan *et al*., 2017). The interest of HEIs in utilising VLC is accompanied by a lively yet inconclusive debate regarding the actual advantages of this approach to enhancing student learning. As described by O'Callaghan *et al*. (2017), many studies present contradictory results when trying to correlate the use of VLC with improving learning. Issues associated with lecture attendance, learning performance, and achievement of learning outcomes have highlighted the advantages as well as weaknesses of "lecture capture", "lecture capturing", or VLC (Evans and Luke, 2020). A prior study (Remião *et al*., 2022) in this debate demonstrated that VLC positively impacted students' ability to comprehend subjects and apply knowledge, contributing to their attainment of intended learning outcomes. VLC had a favourable influence on student academic performance when evaluations were within a time-constrained period.

Video has a long history in education; however, its widespread use in higher education is contingent on infrastructure and the availability of technological equipment. On the one hand, presentation software (e.g. PowerPoint) prompted HEIs to upgrade their lecture facilities, enabling multimedia delivery; on the other hand, the development of virtual learning environments such as Moodle e-learning platforms favoured the delivery of learning resources, expanding technology in education. Moreover, the increased availability of broadband connectivity at home or on campus expanded the infrastructure for incorporating video and audio as common components in education. However, COVID-19 exacerbated the digital divide by denying many students physical access to technology and high-speed internet.

Many socially disadvantaged students became even more so during the crisis, and their numbers are likely to increase. Almost 40% of students had to interrupt or lose their careers, leaving them reliant on family assistance (EUA, 2020).

Within this framework, information and communication technologies are playing a larger role in teaching methods and the interactions between lecturers and students. This shift has accelerated since the COVID-19 pandemic, which intensified the impact of digital learning trends. For instance, a study conducted on university students in Morocco revealed that attitudes and satisfaction with online learning positively affect academic achievement. Factors such as instructor performance, ease of use of the platform, information quality, interactivity, and perceived usefulness significantly influence students' satisfaction and attitude (Chetioui, 2024). In another study examining the shift to online learning in Omani higher education during the COVID-19 pandemic, the challenges and opportunities that HEIs in Oman face in the aftermath of the pandemic were investigated (Magd *et al*., 2022) and in another, critical success factors were evaluated that could be crucial for effectively implementing e-learning in HEIs and developing a framework for successful implementation of e-learning in HEIs in

Oman. These factors include teachers' and students' commitment, self-efficacy and self-regulated approach, pedagogy, involvement of the institution, technology, social interaction, and building up of an e-learning environment (Magd *et al.*, 2022a).

Although the COVID-19 pandemic brought about a new and unprecedented situation, it has also exacerbated and intensified existing problems that were already present before the pandemic (Veiga and Seidenschnur, 2022). For example, autonomous learners may have handled remote work effectively, but other students may have been overwhelmed. As underlined by Remião *et al.* (2022), the enforced shift to blended learning prompted by COVID-19 brings forward the potential benefits of using VLC to support learning and prepare students' assessments. Other benefits identified include increased student satisfaction with VLC videos and improved quality of interaction between students and teachers.

The pandemic also confirmed the relevance of the classroom as a physical location, with students in particular missing out on social interactions. In line with this, careful planning, instructional design, and the most efficient use of face-to-face time for students and teachers within the constraints of institutional infrastructure were essential. At the same time, institutional and pedagogical commitments to promote student body diversity and inclusion in the classroom emphasise the significance of establishing priorities, which can lead to developing better teaching and learning strategies. Under these conditions, the effectiveness of teaching and learning resources based on technology gains momentum.

This paper explores the lessons learned from using VLC before COVID-19 and proposes effective pedagogical strategies to address student diversity in times when COVID-19 intensified the digital divide. In line with this, the main research question addressed in this paper is: To what extent does VLC technology enhance academic performance and student inclusivity in higher education? Two subsidiary questions are also posed: How do undergraduate students use VLC, and what is its impact on pedagogical differentiation? Specifically, the analysis examines how students engage with VLC, measured by the minutes of content viewed, and assesses the impact of this usage on the academic performance of both high-achieving students (A and B grades) and those with lower academic performance (D and E grades).

The research strategy unfolds as a case study (Yin, 1994), framed by how undergraduate students of pharmaceutical sciences used VLC and the impact of VLC on pedagogic differentiation. Looking at the course of Mechanistic Toxicology (MecTox), the objective is to describe this case of pharmaceutical sciences in depth. The analysis uses indirect evidence of student learning collected in 2017/18 and 2018/19. Data includes the use of VLC, global grades, and Moodle test distributions. Other sources of information rely on analysing official and pedagogic discourses shaping VLC in the pharmaceutical sciences. While this paper adds to the debate about VLC's flexibility of learning and its positive impact on student success (Remião *et al.*, 2022), the analysis of a case study demonstrates how the experience which lecturers and students gained during and post-COVID-19 was boosted, underlining the benefits for students with lower academic performance.

We start by featuring VLC as a pedagogic device. By emphasising how VLC serves as a bridge between knowledge and educational practice, this article contributes to shed light on the dynamics of teaching and learning. By means of a case study analysis involving undergraduate pharmaceutical sciences students, we analyse VLC usage patterns and by correlating VLC engagement with overall grades and Moodle test distributions, we discern its impact on academic achievement. Finally, the article will emphasise the importance of promoting access, utility, and quality in pedagogic tools. HEIs should ensure that these tools are designed to be effective and accessible to all students, thereby making diversity a meaningful and tangible aspect of the educational experience rather than a superficial concept.

VLC viewed as a pedagogic device

In Western European countries, one of the most significant challenges in higher education is its continuing massification, which remains unsettling for higher education systems (Scott, 2021).

Alongside this trend, digitalisation impacts teaching and learning strategies and methodologies (Rampelt *et al.*, 2019) and HEIs are required to meet quality standards and the expectations of students regarding the relevance of teaching and learning to them. These trends pose additional challenges to HEIs. New types of students with diverse socioeconomic and cultural backgrounds need to be socially and educationally included, raising questions about the effectiveness of teaching and learning methodologies in promoting student learning, with teachers being pushed to promote diverse pedagogical practices in pursuing student success and academic inclusiveness. Inclusion as a process rather than an end appears as a driver for inclusive institutional practices and pedagogical innovation in the classroom.

In Europe, implementing digital technologies as a strategy for teaching and learning within HEIs is one of the European Commission's main recommendations (European Commission, 2013). In the Portuguese context, political, economic, academic, and sociocultural factors influence the perspectives shaping the use of VLC. In other words, technological drivers and the need to meet the needs of all students co-exist. The Portuguese higher education system struggles with low completion rates and delays in completing degree programmes associated with high dropout rates. OECD indicators (2019) showed that about 25% of adults (25–64-year-olds) in Portugal had attained tertiary education. Although this share still falls below the OECD average of nearly 40%, it represents a considerable improvement over the past decade. Despite high enrolment rates, tertiary attainment in Portugal needs higher completion rates. In Portugal, around 41% of 19–20-year-olds – the age at which tertiary education begins in most OECD countries – are enrolled in tertiary education, above the OECD average of 37%. The completion of tertiary education, however, remains a challenge. Thirty per cent of the students who enter a bachelor's programme graduate within the expected duration of the three-year programme (the average is 39%). These delays are cause for concern since they are associated with higher dropout rates. In Portugal, about 12% of students who enter a bachelor's programme leave before beginning their second year of study, in line with the average. Within six years, the share of students who have left without graduating has increased to 26%, compared with an average of 24%.

Within this framework, the debate about the usefulness of VLC is framed by the concept of "technology", which assumes a wide range of meanings. Technology, viewed as a tool, process, or method by which human capability is extended (Harwood and Eaves, 2020), underlines VLC as a tool to potentially extend the digital pedagogical competencies of lecturers while promoting student learning and the development of their digital competencies.

For sociologists of education, a macro perspective on educational issues underlines how social forces and their outcomes replicate and widen inequalities. The Bernstein theory of the pedagogic device (Bernstein, 2003) sheds light on how knowledge is transformed for educational practices, including curriculum-making, teaching, and learning, framing lecturers' attitudes and HEIs' strategies. Considering the pedagogic device, VLC is shaped by both normative and cognitive perspectives related to established standards, emphasising its relevance in digital teaching and learning environments. This means that within the structure of VLC, there are rules or procedures governing how knowledge is produced, transmitted, and assessed. These rules are likely to establish hierarchies in terms of who has authority over knowledge production and transmission.

Remião *et al.* (2022) argue that VLC prioritises students' experiences as it promotes the learners' input (e.g. participation in class debates), their interests (e.g. taking notes), and achievement of learning outcomes (e.g. capacity to understand the subjects and apply knowledge obtained), underscoring that VLC favours students' experiences. As a result, VLC intersects with learners' experiences, emphasising the importance of digital learning environments in education. Indeed, VLC transcends traditional lecture halls, enabling asynchronous learning. Students can revisit complex topics, pause, rewind, and engage at their own pace. This flexibility accommodates diverse learning styles and preferences.

In this view, the mediation function of pedagogical practices enacted by VLC might enhance the inclusion of students within learning contexts characterised by the advancement

of information and communication technology and student diversity. If this argument is accepted, it brings assumptions into question regarding whether educational systems perpetuate or challenge existing inequalities. Consequently, it is crucial to understand how VLC fosters the inclusion of higher education students. To this end, this study specifically investigates the effectiveness of VLC in promoting inclusion. Inclusion, as discussed by Schuelka and Engsig (2020), is a multi-layered sociocultural process embedded within complex educational systems. To navigate this complexity, this study identifies individual courses, and pedagogical strategies as actual instances of inclusion. The synergy between inclusion and pedagogical approaches significantly influences teaching and learning environments, emphasising educational aspects such as "access", "quality", and "utility" (Schuelka and Engsig, 2020). In other words, in this article, a discussion is provided of the importance of understanding how VLC contributes to student outcomes and academic inclusion.

Research methodology

An explanatory case study, as described by Yin (1994), is used in this study to examine the impact of VLC on student inclusion and performance, utilising a theoretically grounded framework to guide its analysis and statistical comparisons.

Design and implementation of VLC

VLC is integrated into teaching practices with the intention of ensuring that all students have access and opportunities for success. As the impact of inclusion on the academic performance of students reveals promising results (e.g. Jouni and Al-Hroub, 2023; Kefallinou *et al.*, 2020), this study uses academic performance as an indicator of educational effectiveness. VLC in MecTox assumes an outcomes-based teaching and learning model based on constructive alignment (Biggs and Tang, 2011). This framework aligns teaching methodologies, activities, and assessments with the intended learning outcomes to support student inclusion and effectiveness.

Focus on inclusion and educational effectiveness

The analysis was focused on a course within the integrated master's degree programme in pharmaceutical sciences, driven by the need to assess how VLC facilitates inclusion and educational effectiveness. The diversity in students' socioeconomic backgrounds (as noted in Table 1) further motivates this analysis.

Data analysis

The data informing the research question focuses on students' lecture video usage and their grades. All the data and statistics related to student use of lecture videos were obtained in the statistics module of the Panopto platform. Statistical methods are then used to compare academic performance among these different groups, allowing for an analysis of the relationship between VLC usage and student outcomes. After splitting the students by their grades and minutes viewed, statistical methods were used to compare their academic performance. The data analysis was conducted using SPSS software, version 26.0, which provided a platform for executing comprehensive statistical tests and generating detailed insights. Descriptive statistical measures such as proportion, mean, and standard deviation were used to evaluate the data according to VLC usage and students' grades. To determine whether the students who viewed the videos achieved better grades regardless of the percentage of visualisation of the total number of videos, we analysed whether the minutes viewed influenced the students' grades by means of the one-way ANOVA test. The level of statistical significance is 0.05.

Table 1. Characteristics of the students enrolled in the pharmaceutical sciences degree programme

	2017/2018 $N = 959$ students	2018/2019 $N = 849$ students
Graduates students' average mark	14	14
Average mark of approved students in the ToxMec course	13.2 ± 2.2	12.6 ± 2.2
Female/Male	766 (80%)/193 (20%)	746 (79%)/203 (21%)
<25 years old	851 (89%)	841 (90%)
Academic qualification level Father/ Mother	≤9 years of schooling: 409 (55%)/318 (40%) Upper secondary education 214 (22%)/191 (20%) tertiary education 213 (22%)/281 (29%) info not available 123 (13%)/106 (11%)	≤9 years of schooling: 402 (43%)/363 (38%) Upper secondary education 231 (24%) tertiary education 223 (23%)/301 (32%) info not available 92 (10%)/76 (8%)
Student-workers	72 (8%)	73 (8%)
Students living away from their residence area	280 (29%)	262 (28%)
Students holding a grant of economic and social support	270 (28%)	240 (25%)
Source(s): Authors' own work		

Multiple sources of evidence and theoretical propositions guided the data collection and analysis. According to Creswell (2003), in case study research, the researcher explores a "real-life, contemporary bounded system (a case) or multiple bounded systems (cases) over time, through detailed, in-depth data collection involving multiple sources of information" (97). In this study, the research design is expected to allow for a more in-depth understanding of the effectiveness of VLC in promoting students' inclusion.

The case study inquiry
The research strategy firstly evolved by aligning the data collection methods with the study questions. Based on the assumption that VLC would improve student learning (Remião *et al*., 2022), the need to collect statistical data on VLC usage allowed for an understanding of how undergraduate students of pharmaceutical sciences use VLC. Additionally, the assumption that VLC would improve student learning reflects a theoretical issue regarding the inclusion of students and benefits for their progression. Thus, the students' global grades and Moodle test distributions across two academic years were analysed to understand the impact of VLC on pedagogic differentiation.

Secondly, by looking at the course of MecTox as a major instance of inclusion, it is considered the unit of analysis. Undergraduate students enrolled in MecTox (see Table 1) were chosen as the case study topic to describe how inclusiveness drives pedagogical initiatives and contributes to students' progression in pharmaceutical sciences. The beginning and end of this case are the academic years of 2017/18 and 2018/19.

Thirdly, interpreting the findings involves grappling with challenging questions about how pedagogic devices function as mechanisms for inclusion. Given the hierarchical nature of the principles influencing pedagogic devices, this case study suggests the potential to transform teaching practices by incorporating research into teaching and learning. An integrated view of the curriculum, including the evaluation of practices, is key to mapping the impact of pedagogies on student learning. As digital education trends continue to expand, the literature increasingly highlights the need for research on pedagogies, particularly in the context of blended learning (BL). BL offers opportunities for collaboration and improved learning

outcomes, but it also raises concerns about its long-term impact on teachers' professional development and the potential challenges it poses to traditional teaching methods. This underscores the importance of examining how innovative pedagogical approaches using technology can be effectively integrated into evolving teaching methods (Ansari, 2024).

The quality of the research design took validity and reliability into account as dimensions of quality of pedagogic research (Evans *et al*., 2020) by (1) relying on multiple sources of evidence (e.g. students' grades in Moodle exams and students' global grades in the degree programme), (2) doing explanation-building data analysis to establish relationships between the use of VLC and students' grades as indirect pieces of evidence of student learning, (3) using theoretical approaches focusing on VLC as a pedagogic device to illuminate the case study and (4) assuming an integrated approach regarding the introduction of VLC relying on data collection procedures that can be repeated. The Institutional Ethics Commission approved the study to fully comply with research ethics, norms, codes, and practices established in the European Union.

Mechanistic Toxicology as a primary instance of inclusion

At the level of disciplinary fields, the "official" discourse mediating the extent to which there is explicit and agreed content to be transmitted to students is featured in European policies and by national and international organisations regulating the professional practice of pharmacists. Assuming that graduates would practise within different health, social, and research systems, different regulations and belief systems challenge students' socioeconomic and cultural backgrounds and affect learning outcomes. Including such information regarding the students' backgrounds (see Table 1) would provide further context for interpreting the research findings.

It is essential to highlight students' high dropout rate and poor academic results in the first three years of the selected degree programme to capture the circumstances and conditions that framed the introduction of VLC in MecTox. Among the students enrolled in the first year, 31% (61) dropped out. After three years, the dropout rate slightly increased to 32% (64 students). Compared to 2017, there was a marked decrease (38%) in degree graduates in 2018 regarding academic results. Additionally, 101 graduate students at the end of the third year had the second-lowest average (12.4 points out of 20) among all degree programmes taught at the university. Notably, only 27% of students completed at least 45 ECTS at the end of the first year (Porto, 2019). The characteristics of the students enrolled in the pharmaceutical sciences degree programme in the academic years under scrutiny are shown in Table 1, as mentioned above.

Considering the characteristics of the students enrolled, diversity within the classroom depends upon the quality enhancement of teaching and learning. Following Biggs and Tang (2011), students' academic orientation and commitment are a source of diversity. As shown in Table 1, the academic qualification levels of student's parents and the conditions (e.g. student-workers, living away from home, holding a grant of economic and social support) contribute to the diversity of the student population, challenging appropriate teaching and learning strategies and activities that might close the gap between students. In line with this, these students' conditions would provide a contextual understanding of the research findings. The "pedagogical" discourse, involving choosing suitable teaching, learning, and assessment methods, incorporates institutional norms defining student workload. This discourse also influences the pedagogic autonomy of academic teaching staff in selecting appropriate strategies and methods.

The diversification of students' expectations and satisfaction with learning experiences, what they learn as a result of those experiences, and what they learn to help them achieve their and their teachers' objectives are considered while convening VLC. The goal of implementing VLC in this case study was to add value to the teaching and learning processes and the students' experiences to make these processes relevant and meaningful while actively contributing to their progress, favouring inclusion. The rationale for a single case is the

representativeness of MecTox as a relevant example of inclusion in a pharmaceutical sciences degree programme focusing on the use of VLC. The introduction of VLC represents a typical project of pedagogical innovation, in which lessons learned from this case are assumed to be informative about the experience undertaken in the context of a degree programme. The sample (320) comprises the number of undergraduate students who were assessed in two academic years (2017/18: 157 and 2018/19: 163). The aim of the present study is to analyse the presumed relationship between the use of VLC and students' grades.

Results

How do undergraduate students of pharmaceutical sciences use VLC?
In the process of implementing VLC in MecTox, lectures were performed with slide presentations while recording the teacher's voice. The "Explain Everything" application was used to record the lesson (using an iPad and an AppleTV as an interface to the projector), and the respective videos were later made available to students through the Panopto platform inserted in the curricular unit's Moodle page. The implementation of VLC was monitored and evaluated concerning the pedagogical management of the integrated master's degree programme in pharmaceutical sciences.

The VLC was applied in three classes of theoretical contextualisation of practical and laboratory contents of MecTox and corresponded to 260 min of video. Students were evaluated on this component using the Moodle platform in an exam in the mid-term evaluation. This assessment consisted of twelve multiple-choice questions that assessed whether students memorised concepts related to the content taught and an open question to assess whether students demonstrated the capacity to apply knowledge.

A set of parameters was selected to monitor students' use of the VCL. Statistical tools from the Panopto platform were used to conduct a detailed analysis of students' use of videos, including viewing time, periods of the most viewed videos, weeks with the highest intensity of viewing the videos considering academic calendar activities and viewing time of the videos by each student. In addition, in this study, the student's grades in the Moodle exam and the respective course average, expressed according to the European Classification Comparability Scale, were analysed at the end of the fourth academic year.

The main results of this study showed that more than 90% of the students evaluated in the Moodle exam viewed the videos. On average, the total viewing time, 98 min, was higher than the average number of minutes of video available (see Table 2).

The high usage of videos allows us to conclude that most students viewed the videos in their entirety. In terms of the visualisation calendar, there was a greater intensity of visualisations in the weeks preceding each of the evaluation periods, with the highest peak (about 75% of the total) occurring three weeks before the evaluation in the mid-term evaluation and using the Moodle platform, as already referred to. These research findings corroborate the literature, according to which students pragmatically use VLC in preparation for the assessment (Murphy and Stewart, 2015).

Table 2. Details about the videos provided to the students

Vídeo	Video duration (min)	Average of the minutes viewed by the student	% Of the students who viewed the videos/ students who were evaluated
1	90	97.4	97%
2	90	102.7	92%
3	80	95.1	91%
	260	*98.4*	*94%*

Source(s): Authors' own work

To explore the influence of VLC on the achievement of all the students, we established three groups considering students' global grades on a scale of 0–20, according to the European Classification Comparability Scale.

(1) A and B correspond to the 35% of students with the best ratings: 13.9–20;

(2) C corresponds to 30% of students with intermediate grades: 12.8–13.8;

(3) D and E correspond to 35% of students with the most modest grades: 0–12.7.

Additionally, we set up three groups of the relationship between the minutes viewed by each student over the total of minutes of videos (i.e. three videos of 260 min in total). These groups consist of.

(1) low: 22% of students who viewed between 0 and 40% of the total minutes of videos;

(2) moderate: 41% of students who viewed between 40 and 105% of the total minutes of videos; and

(3) high: 37% of students who viewed between 105 and 500% of the total minutes of videos.

As shown in Table 3, A and B students, representing 35% of students with better ratings, gained more positive results by viewing the videos. Having viewed the videos for more than 200 min, those students obtained all the ten best ratings. C students, corresponding to 30% of students with intermediate classifications, showed a slight improvement in their academic results when viewing the videos. The analysis of the results showed that the visualisation of the videos by students whose grades were D and E, which corresponds to 35% of students with the most modest ratings, was quite favourable, with a strong positive trend in terms of the minutes dedicated to viewing the videos and the performance of the students. These findings have led the research team to suggest that there may be something to learn from the effectiveness of VLC in reconciling inclusivity with high student performance.

To determine whether the students who viewed the videos achieved better grades regardless of the percentage of visualisation of the total number of videos, a one-way ANOVA demonstrated that the effect of visualisation of the total number of videos was significant for the groups of D and E students' grades ($F (2, 109) = 12.049$, $p < 0.001$). The effect size, eta

Table 3. Students' grades and the relationship between the minutes viewed and the total minutes of videos

Students grouped by the European classification comparability scale (ECTS)	Students grouped by the relationship between minutes viewed/total minutes of videos	Number of students	Average grade in the Moodle test
A and B students' grade courses	Low	22	77.61
	Moderate	46	78.17
	High	44	78.24
Total		112	
C students' grade courses	Low	20	57.25
	Moderate	43	62.03
	High	33	64.73
Total		96	
D and E students' grade courses	Low	27	37.08
	Moderate	41	46.22
	High	42	56.16
Total		112	
Source(s): Authors' own work			

squared (η^2), was 0.181, indicating a large effect of the minutes dedicated to visualising the videos on the grades of D and E students. In turn, the one-way ANOVA test showed no statistically significant differences between the minutes viewed and the grades in the Moodle test by A, B, and C students (see Table 4).

To analyse which group of students within those with D and E grades performed better, a Bonferroni post-hoc test (see Table 5) revealed significant pairwise differences ($p < 0.001$) between those with low viewing times (38.12 min) and high (up to 1,250 min of videos). This result suggests that the minutes viewed influenced the average grade of D and E students on the Moodle test.

VLC thus contributed to reducing the performance gap between students while supporting the performance of those students with poor academic results. It is thus suggested that VLC promotes the equality of academic success among pharmaceutical sciences students, paving the way for developing VLC as a differentiated pedagogical device.

Discussion

The research findings contribute to the discussion on the necessity of diversifying teaching and learning processes to foster equal success – an essential dimension in the pedagogical innovation process. This issue is increasingly important in the post-pandemic era since COVID-19 has exacerbated existing economic, social, cultural, and academic inequalities, challenging digital transformation in higher education.

Framing VLC as a pedagogic device, its educational value can be recognised. It fosters differentiation, evidence-based decision-making, and innovative strategies for student success. Academic teaching staff can tailor content delivery, address misconceptions, and reinforce key concepts. Considering the academic qualifications of parents (less than or equal to nine years of schooling – 38%–55%) and the students receiving social and economic support

Table 4. Results of one-way ANOVA and Effect Sizes

		F	*Z*	Sig	η^2
A and B students' grade	Between groups	2	0.015	0.985	0.000
	Within groups	109			
	Total	111			
C students' grade	Between groups	2	1.331	0.269	0.028
	Within groups	93			
	Total	95			
D and E students' grade	Between groups	2	12.049	<0.001	0.181
	Within groups	109			
	Total	111			

Source(s): Authors' own work

Table 5. Multiple Comparisons of D and E students' grade with minutes viewed

	Minutes viewed	Minutes viewed	Mean difference	Std. error	Sig
D and E students' grade	Low	Medium	−8.8	3.8	0.073
		High	−18.8	3.8	<0.001
	Medium	Low	8.8	3,8	0.073
		High	−9.9	3.5	0.017
	High	Low	18.8	3.8	<0.001
		Medium	9.9	3.5	0.017

Source(s): Authors' own work

(almost one-third of students), the "pedagogic" discourse shaping VLC in MecTox underlines its potential for fostering differentiation.

Firstly, the effectiveness of VLC as a pedagogic communication tool, an actual outcome of student performance in MecTox, highlights its value as a differentiated pedagogic device. This approach acknowledges students as the main contributors to their intellectual development while recognising that VLC facilitates their inclusion. Indeed, the visualisation of the total number of videos was significant for the group of D and E students' grades (0–12.7), contributing to their grades surpassing both the average mark of approved students in the MecTox course (12.6) (see Table 1) and the second-lowest average (12.4 points out of 20) among all degree programmes taught at the university (Porto, 2019).

Secondly, the educational value of VLC as a differentiated pedagogic device provides new insights that deserve further investigation across other courses, degree programmes, and disciplinary areas. On the other hand, what students learn from their experience with VLC can make them more aware of the learning process and more involved with how knowledge is constructed in their scientific area (Rogers, 2004). From this perspective, using VLC as a differentiated pedagogical device and not only a tool to foster the improvement of results can be a factor for success as it promotes student-centred teaching and active learning (Groen *et al.*, 2016). The positive impact of VLC on students' assessment results, particularly D and E students with more modest grades, was already observed in previous research (Murphy and Stewart, 2015; Nordmann *et al.*, 2019). This impact has possible implications for student learning, as recognised in the literature (Crook and Schofield, 2017; Murphy and Stuart, 2015).

Thirdly, the research findings pointing out VLC as a differentiated pedagogic device bring up the characteristics of the students enrolled in the pharmaceutical sciences degree programme (see Table 1). In line with this, the attributes of education such as "access", "quality", and "utility" (Schuelka and Engsig, 2020) allow us to explore further elements shaping the use VLC in MecTox.

Access as an educational attribute broadens the concept of "full access" (Lewin, 2007). The massification of higher education systems is not guaranteed unless time is spent on task, progression, and achievement of learning outcomes to create the conditions for graduates to develop professional skills, independent problem-solving, and lifelong learning. VLC promotes the right to access education and individual access to knowledge. Promoting access to the curriculum and learning materials enables pedagogical communication. VLC can be seen as a form of turning knowledge into pedagogical knowledge that is accessible and useful for a diverse set of students. Accessibility implies that VLC converts knowledge to be used in different settings beyond the "borders" of the university campus.

The research findings underline that VLC provided differentiated teaching and learning approaches before the COVID-19 pandemic. The use of VLC as a pedagogical communication means contributed to blurring the boundaries between means of knowledge transmission, thus reflecting how teaching and learning took place in diverse social contexts. Diverse settings where the students learn to interpret knowledge might correspond to differentiated spaces that promote their autonomy, the freedom to learn at their own pace, and the inclusion of those students.

VLC allows students to acquire knowledge at their own pace outside the classroom (Bos *et al.*, 2016). Flexibility brings students into spatial, epistemological, and professional contexts within which knowledge is transmitted and reproduced. The educational value of VLC in terms of "access" to knowledge is visible in this study considering the minutes viewed by the students and its impact on students' learning, namely those students rated D and E with more modest grades. In turn, VLC promoted active learning in differentiated spaces from which knowledge is accessed. Indeed, considering that 38%–55% of the students' parents have less than or equal to nine years of schooling (see Table 1), this reinforces the need for institutional policies and strategies geared towards widespread access to the videos.

The search by academic teaching staff for adequate means for leading diverse students to acquire and translate knowledge and its application is done, in this case, with the students

rather than for the students. While VLC promotes "access" to knowledge production, it underlines its value as a means of implementing inclusion processes, thus enhancing the development of society.

Interdependent and integrated with the attribute of "access" is the element of "quality". Within European higher education systems, responses to the increased demand are needed to meet the need to adapt quality at the system and institutional levels (Biggs and Tang, 2011). The Portuguese system of quality assurance and accreditation emphasises the "official" pedagogic discourse that HEIs should develop a quality assurance policy for their programmes, alongside a culture of quality, quality assurance mechanisms, and a strategy for continuous improvement. In line with this, implementing VLC in MecTox reduced the gap among diverse students, addressing the quality of teaching and learning. VLC accommodated the interests of a diverse range of students reflected in the qualification level of their parents and their socioeconomic conditions (see Table 1), all demanding quality of teaching and learning.

In addition to these attributes, this study shows a potential "utility" of VLC beyond its function of transmitting knowledge. In fact, for the MecTox students (of whom almost one-third live away from their residence area and/or hold a grant of economic and social support), VLC is essential for the valorisation of said transmitted knowledge as it provides equal opportunity for accessing and applying knowledge, assuming that students have the necessary infrastructural conditions at their disposal.

When analysing VLC and its educational value, it becomes clear that it is interrelated with "access" and "utility". Viewing lecture recordings as an artefact representing the lecturer and students' collective interpretation of the lecture act emphasises the importance of lecturers and students sharing responsibility for the production and recording. This sharing of responsibility challenges the hierarchical nature of VLC as a pedagogic device and potentially contributes to a shift in teacher-student relationships in higher education.

Conclusion

The analysis of research findings reinforces VLC as promoting inclusive and differentiated pedagogical practices to address diversity effectively. This case study shows the importance of recognising individual courses and pedagogical practices developed from within as examples of inclusive practices in higher education. As observed, academic teaching staff might expect VLC to meet the educational rights of diverse students.

The introduction of VLC has gained traction in post-COVID-19 education, marked by the need for a strategy to move education online quickly. VLC's flexibility for students and academic teaching staff should be combined with a critical reflection on its fitness for the purpose and its benefits for teaching and learning.

Overall, the findings emphasise the need for HEIs to adapt curricula and pedagogical practices to address the diverse needs of students. This includes designing inclusive teaching strategies and learning environments that accommodate various student backgrounds and conditions, such as those with different socioeconomic statuses or living situations. This suggests that HEIs should develop strategic actions and policies that specifically address diversity. The implications of research findings for society bring the issue of equity in education to the fore. By addressing the diverse needs of students, HEIs can contribute to greater educational equity. Ensuring that students from various socioeconomic backgrounds and living conditions have equal opportunities can help level the playing field and promote social mobility. This has broader societal benefits, such as fostering a more inclusive and understanding society that values and supports individuals from different backgrounds. By equipping students with the skills and experiences to navigate and contribute to a varied professional and social environment, higher education can positively impact societal development and economic growth. In other words. VLC not only benefits students by providing equitable access to education but also potentially has broader societal implications, promoting fairness and supporting social and economic development.

The findings may have limited generalisability beyond the specific context and sample used. However, this study allows the research findings to be compared with previous research (Remião *et al.*, 2022), contributing to the debate on how pedagogic research can promote evidence-based decisions regarding innovative strategies. The meaning of educational inclusion processes and diversity is, thus, contingent on the institutionalisation of research as a practice of teaching and learning. Evaluating pedagogical practices developed by academic teaching staff is key to mapping the relationships between teaching and learning methodologies and student learning. This case study sheds light on the connection between research-based approaches to teaching and learning practices and the effectiveness of student learning.

In restoring higher education for the post-COVID-19 era, by underlining inclusion processes as a response to the diversity of students in higher education, these research findings have the potential to impact institutional policies and individual practices, focusing on curricular and pedagogic management of diversity. The results of this study thus provide interesting insights for the design of strategic action, considering the diversity of students as seen in parents' academic qualifications and students' conditions (e.g. student-workers, living away from home, holding a grant of economic and social support).

Diversity as a concept might be called an "empty" signifier, and its value depends on the conditions academic teaching staff, students, and HEIs have to promote "access", "utility", and "quality" as characteristics of pedagogic tools. Using VLC as a differentiated pedagogic device might give diversity "real" content insofar as institutional and national policies can mitigate the possible negative effects of parents' low academic qualifications and the students' conditions of living away from their residence area and holding a grant of economic and social support.

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