Audio-visual resources and learning improvement: an experimental analysis

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Abstract: The general objective of this research is to analyse the students' learning performance on the use of audio-visual resources in the subject of didactics of the business and its environment, taught in master's degree in Teacher Training of High School, Vocational Training and Language Teaching (specialty in Economics, Business, and Commerce) at the University of Nebrija. This study applied the experimental method from two randomly generated samples of the two groups (virtual classrooms) into which the enrolled students were administratively divided. The results obtained by the experiment point to a significant improvement in the students' learning performance, and their perception about the use of this didactic tool turned out to be very positive.

Keywords: audio-visual resources; digital teaching resources; videos in class, audio-visual didactics; multimedia teaching; learning; learning improvement, virtual classrooms; experimental method; experimental analysis.

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1   Introduction

Studying a subject such as didactics of business and its environment can be an arduous task for graduate university students, mainly because it involves activating different capacities and competencies related to abstract thinking, the ability for analysis, the study of cases, or calculation skills, among others. To solve this problem and facilitate access to knowledge and mastery of the subject, teachers must consider different creative strategies that help students in their academic progress, such as, for example, gamification, simulations, or the flipped class (flipped classroom), among others (Anderson and Neri, 2012; Naz and Murad, 2017; Angelini, 2021; Gyau et al., 2021). One of these possible strategies deals with audio-visual resources in the virtual classroom (Lagoa et al., 2018; Valls and Oliva, 2020; Torres et al., 2021). This educational approach also requires a change in the teacher's role, who becomes a curator or content manager, selecting and organising all types of online materials (Mena, 2014). Due to the lack of guidelines on the didactical use of videos in class, teachers have no choice but to be guided by intuition and experience (Wijnker et al., 2019).

Historically, the use of video as a didactic resource has been transformed according to technological possibilities, focusing its implementation on video case studies (Herreid, 1997), video-based self-reflection (Van Es and Sherin, 2002), video podcasts (Heilesen, 2010; Kay, 2012) or video clips (Berk, 2009). However, since 2005, the year of creation of the YouTube platform, the use of video in the classroom through the internet has increased, becoming one of the most widely used educational resources today due to technological change and new ways of learning by students (Rangarajan et al., 2019; Pattier, 2021).

Audio-visual resources allow the teachers to introduce any aspect of business dynamics and its circumstances in the classroom, as well as contextualise the learning process both in a traditional classroom approach and in a flipped classroom environment (Valls and Oliva, 2020; Pepin et al., 2021; Salas, 2021). Students attend the classroom more regularly, improve their commitment to the subject, increase their interest in learning, and obtain better academic results (Tiernan, 2015; Bonsignori, 2018; Helfenstein et al., 2020; Gerbaudo et al., 2021). These impacts have been especially evident during the COVID-19 pandemic (Torres et al., 2021).

This research explores the learning performance of the postgraduate students of the master's degree in Teacher Training of High School, Vocational training and Language Teaching (specialty in Economics, Business, and Commerce) of the University of Nebrija on the use of audio-visual resources in the virtual classroom of the subject teaching of the company and its environment. The study addresses the following research questions:

RQ1   Does the use of audio-visual resources impact the students' learning performance?

RQ2   What are the students' perceptions regarding the didactical use of audio-visual resources in the classroom of didactics of business and its environment?

This work is structured as follows: Section 2 deals with the literature review; Section 3 sets out the methodology; Section 4 shows the experimental design; Section 5 collects the results obtained and, finally, Section 6 summarises the conclusions.

2 Literature review

2.1 Digital technology, educational videos, and higher education

The last decade has witnessed crucial changes in the landscape of higher education, among which we can highlight the use of technology to improve learning at all levels of the education system, in general, and in university education, in particular. Digital technologies have improved traditional face-to-face training by incorporating hybrid systems – face-to-face and distance -, or by betting firmly on online training (Daniels and Thistlethwaite, 2016; Deborah et al., 2017; Carroza, 2018; Huggett, 2019).

It is possible to consider the impact of digital technology from different perspectives, including the economic, social, and student experience. Several meta-analyses have shown that technology can improve learning (Schmid et al., 2014; Orús et al., 2016; Castro and Tumibay, 2021), while other works question this view (Kirkwood, 2009; Kirkwood and Price, 2014; Englund et al., 2017; Popova et al., 2020). Beyond the pros and cons identified by the academic literature regarding the use of technology in education, it is necessary to underline the task of continuing to understand the impact of technological transition and transformation on people (Buckingham, 2000; Hockey and James, 2017; Ihmeideh and Alkhawaldeh, 2017; Livingstone and Blum-Ross, 2020).

Audio-visual resources, specifically designed to achieve learning outcomes, are a significant part of the technology-enhanced evolution of learning (Tiernan, 2015). They are the basis of many distance education courses and are increasingly becoming the leading information transmission mechanism (Thomson et al., 2014; Brame, 2016; Wijnker et al., 2019; Shiu et al., 2020; Belt and Lowenthal, 2021).

2.2 Impact of audio-visual resources on students' learning

The academic literature on the impact of audio-visual resources on students' learning is significantly sparser compared to research devoted to assessing those same impacts on the students' experience in the classroom (Lokuge et al., 2017; Harrison, 2020; El-Sabagh, 2021; Nkomo et al., 2021; Schulz and Iskru, 2021). This orientation of research is not surprising given that the experience and satisfaction of students are empirically easier to measure through surveys and interviews than the impact on their learning since, in this second case, the use of more complex experimental methods is necessary (Heilesen, 2010; O'Bannon et al., 2011; Kay, 2012; O'Callaghan et al., 2017; Pattier, 2021).

The impact of audio-visual resources on learning, essentially, will depend on their content (Hansch et al., 2015; Laaser and Toloza, 2017; Harrison, 2020; Lackmann et al., 2021). Students seem to learn best from multimedia presentations when they are not simple speeches in a traditional lecture style, like monologues, but when they incorporate dialogues and discussions between students and teachers or reflect on the most common mistakes in the learning process (Muller et al., 2008; Chi et al., 2017; Ding et al., 2021). On the other hand, the use of audio-visual resources may require not only a different pedagogical approach to that used in conventional teaching but even a different teacher profile (Noetel et al., 2021b).

Research from different disciplines, and not exclusive to distance learning, has shown that video can be an effective educational tool in improving study habits and increasing

learning performance (Beege et al., 2017; Ghilay, 2018; Vittorini and Galassi, 2021). Audio-visual resources allow students the construction of mental representations through the combination of words and images that favours learning and, consequently, higher academic performance (Abdulrahaman et al., 2020; Harrison, 2020; Noetel et al., 2021a).

Almost all the academic literature emphasises that the features embedded in these videos -rather than the videos themselves- are the ones that enhance students' learning. Research has shown that the creative use of colour, contrast, and highlighting of information helps students focus their attention, retain new knowledge, and reduce cognitive overload (Xie et al., 2019; Kokoç et al., 2020; Wang et al., 2020). On the contrary, the academic literature also found that too much information on the screen can significantly reduce retention (Laaser and Toloza, 2017; Zureick et al., 2018; Iskru and Schulz, 2020; Schulz and Iskru, 2021).

Besides helping the acquisition of knowledge, the academic literature has also reflected on whether audio-visual resources could help students build new knowledge (Thomson et al., 2014; Tiernan, 2015; Belt and Lowenthal, 2021; Mirriahi et al., 2021). The didactic use of audio-visual resources improves the understanding of the content, positively impacting the students' grades and their academic performance (Fuller and France, 2016; Bohloko et al., 2019). Greater depth of learning occurs along with the likelihood of curiosity and greater engagement with the learning experience when students are encouraged to do something during or after watching the video (Pritchard, 2017; Gadille et al., 2021). In this sense, audio-visual resources can inspire and involve students when incorporated into learning tasks (Pirhonen and Rasi, 2017; Raj et al., 2019) and improve their communication skills (Karami, 2019).

3   Methodology

This study used the experimental method to answer the research questions posed in this work. This methodology has been and is widely applied in research related to teaching and learning in very diverse areas of knowledge (Friedman and Sunder, 1994; Smith, 2010; Durlauf and Blume, 2016; Kagel and Roth, 2020; Guimarães and Lima, 2021; Kusainov et al., 2021; Levchyk et al., 2021; Mateu, 2021).

The experimental method is suitable for identifying causal relationships (Friedman and Sunder, 1994; Smith, 2010; Durlauf and Blume, 2016; Kagel and Roth, 2020) and evaluating – thanks to the possibility of control – the impact of the use of audio-visual resources on the classroom (independent variable) on learning performance (dependent variable). To this advantage is added another related to replicability: the experiments can be reproduced as many times as required to confirm or refute the evidence of the results obtained, which provides transparency to the research process (Srinagesh, 2006; Smith, 2010; Kagel and Roth, 2020; Rogers and Revesz, 2020).

Like any research method, the experimental methodology has disadvantages related to the problems of control of the investigated variables, the non-representativeness of the selected samples, or the possible incomparability of the established groups, among others (Friedman and Sunder, 1994; Ross and Morrison, 2013; Rogers and Revesz, 2020). These disadvantages are part of the limitations in its application, and this research tried to control them to minimise their effects on the experimental process carried out (Srinagesh, 2006; Rogers and Revesz, 2020).

4 Experimental design

The experimental sessions took place in the second semester of academic year 2020–2021 in the subject didactics of business and its environment, taught in master's degree in Teacher Training of High School, Virtual Training and Language Teaching (specialty in economics, business, and commerce) at the University of Nebrija. The platform used for the teaching experiments was blackboard.

Those enrolled in the subject, divided into two independent virtual classrooms, had different schedules, so communication between groups was not possible. The virtual classrooms were administratively named A–G, the first, and H–O, the second. Table 1 shows the number of students enrolled in the subject and the number of randomly selected students from each one.

Table 1 Number of enrolled and selected students in the samples

	A–G classroom	H–O classroom
Enrolled students	62	67
Randomly generated samples without repetition	M1	M2
Number of students in the samples	30	30
Males in the samples	11	13 (43.3%)
	(36.6%)	
Females in the samples	19	17
	(63.3%)	(56.6%)

Source: Own elaboration

The experimental process began on March 1, 2021, defining the stages of the research (see Figure 1). The study followed the ethical principles of the Declaration of Helsinki (WMA, 2021). Before their participation, the researchers informed the selected about the objectives of the study and the ethical guidelines followed in the design and treatment of the data, granting their explicit consent by signing a document that collected such goals and ethical principles.

Figure 1 Experimental process
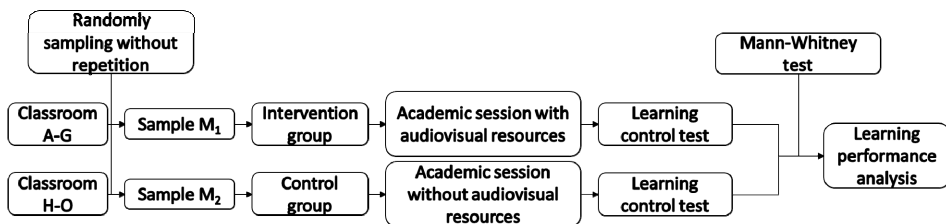
Source: Own elaboration

On March 8, 2021, the students were randomly selected from the enrolled students in each group (A–G y H–O). The process was as follows: first, each student was assigned a number corresponding to the position on the class list; second, with a random number generator, the researchers obtained 30 numbers; third, the researchers contacted these

students to participate in the experiment. If accepted, then formed part of the sample; otherwise, the researchers generated new random numbers to cover the vacancies until reaching 30 students.

On March 15, the participants of the two samples, contacted through the blackboard platform, had a 45-minute academic session to expand on a topic of the teaching guide. After this session, they were given a gamified knowledge control test through quizizz to evaluate their learning performance. This tool was used in numerous studies (Darmawan et al., 2020; Meepung et al., 2021; Mu and Guo, 2022; Zainuddin et al., 2020). The test consisted of a battery of 20 multiple choice questions, with four possible alternatives of which only one option was correct. The maximum time to carry out the control test was 40 minutes since researchers programmed the game to limit the response time to two minutes for each question. At the end of the game, the students belonging to the intervention group had to answer the following open question: what do you think about using audio-visual resources in the classroom?

On March 22, before performing the analysis derived from comparing the results obtained in the control test, the Mann-Whitney non-parametric inference contrast was applied on the samples M1 and M2 to verify whether there were significant differences between the intervention group and the control group and to reinforce the results obtained.

5   Findings

The scores obtained in the control test carried out on each sample are shown in Table 2, ordered from lowest to highest score. The first and third columns collect the students' identification code which coincides with the random number generated by the sampling process. The second and fourth columns show the scores obtained by each of the students in the two groups. Since there are 20 questions asked, the score ranges from 0 (no correct answers) to 20 (all questions correct).

As seen in Figure 2, the distribution of absolute frequencies of the intervention group is better situated in the highest scores, compared to the control group, whose frequencies distribution does not exceed the intervention group in the highest scores. In summary, the intervention group obtains, overall, better scores than the control group.

Figure 2 shows the distribution of absolute frequencies for each of the two samples.

The Mann-Whitney non-parametric inference test reinforces the result obtained (see Table 3).

Given that the size of the samples is greater than 20, the sampling distribution of U approximates to a normal distribution that, once typified, allows us to calculate the Z_U value and make its comparison with the Z value in tables of the normal distribution N (0, 1) for a given confidence level that allows determining which hypothesis is accepted. In this case, the Mann-Whitney test result implies the acceptance of H1 (the alternative hypothesis) as the value of Z_U is greater than the value of Z for a confidence level of 99% ($\alpha = 0.01$), which means that there are significant differences between both samples due to the treatment applied to M1 derived from using audio-visual resources in the academic session. Thus, the experiment shows that learning performance is higher in the intervention group than in the control one because of the use of audio-visual resources (Schmid et al., 2014; Orús et al., 2016; Castro and Tumibay, 2021). In short, using audio-visual didactical resources in the classroom improves the understanding of the

content and, therefore, the student's scores (Fuller and France, 2016; Bohloko et al., 2019).

Table 2   Scores obtained

| Control group (M2)		Intervention group (M1)	
Randomly generated identification code	*Score (between 0 y 20)*	*Randomly generated identification code*	*Score (between 0 y 20)*
37	8	48	10
31	8	45	10
32	8	52	11
53	8	24	12
57	8	33	12
17	9	14	13
55	9	16	13
1	9	49	13
21	9	5	14
18	9	3	15
59	9	37	15
47	10	44	15
34	10	41	16
60	11	15	16
41	12	54	16
8	13	21	16
12	13	47	17
50	15	17	17
4	15	38	17
28	16	18	17
5	16	59	17
3	16	39	18
10	17	31	18
25	17	8	19
35	17	12	19
27	18	28	19
33	19	22	20
39	19	50	20
23	20	30	20
56	20	2	20

Source: Own elaboration

As noted above, the intervention group students answered an open question at the end of the test: what do you think about using audio-visual resources in the classroom? The responses mostly showed six recurring expressions in a good part of the students' responses about the use of audio-visual resources in the classroom:

1   I attend

2   I participate

3   I am motivated

4   I learn

5   I have fun and, finally

6   I study better.

Table 4 lists the recurring expressions detected.

Figure 2   Absolute frequencies distribution (see online version for colours)
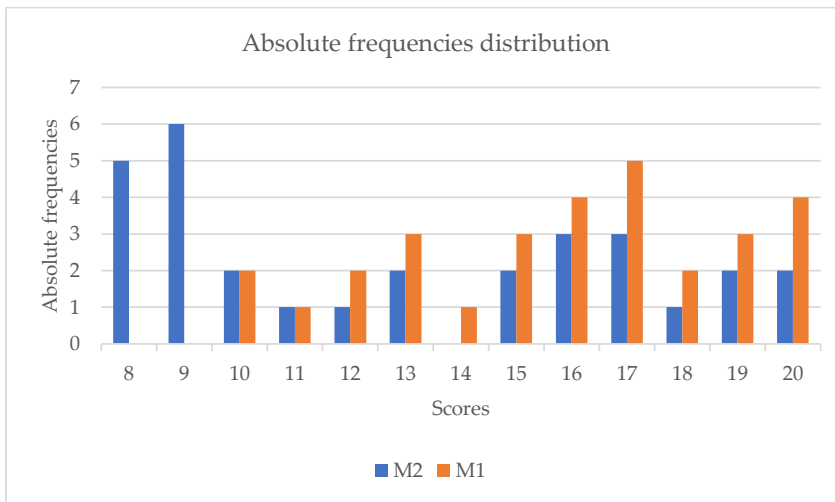
Source: Own elaboration

Table 3   Mann-Whitney test

Sample	n_i, $(i = 1, 2)$	U_i, $(i = 1, 2)$	Z_U	$Z_{0.01}$	Result	Hypothesis
M1	30	236	−3.16	−2.576	$Z_U > Z_{0.01}$	H_1 is accepted and H_0 is refused.
M2	30	720	3.99	2.576		

Source: Own elaboration

The analysis of the interviews revealed that most of the participants seem to agree that the audio-visual resources held their attention (Xie et al., 2019; Kokoç et al., 2020; Wang et al., 2020), encouraged their participation and interaction, increased their motivation, facilitating their learning (Pritchard, 2017; Gadille et al., 2021) in an entertaining and fun way. The students considered that the use of audio-visual resources in the classroom improved their study habits (Beege et al., 2017; Ghilay, 2018; Vittorini and Galassi, 2021) and, consequently, they have higher academic performance (Abdulrahaman et al., 2020; Harrison, 2020; Noetel et al., 2021a).

Table 4 Recurring expressions in the intervention group

Expression	Number of students who use it	Recurrence percentage
I attend, attentive, attention	25	83.3%
I participate	20	66.6%
I am more motivated	23	76.6%
I learn	29	96.6%
I have fun, it's fun, entertaining	27	90.0%
I study better, I study more	18	60.0%

Source: Own elaboration

The audio-visual resources used were selected and designed bearing in mind the need to be very dynamic: incorporating music, graphic effects in the form of short cartoon-like shorts, or as small trailers with a suggestive voiceover, among other items (Xie et al., 2019; Kokoç et al., 2020; Wang et al., 2020). The students in the intervention group valued positively these aspects and dynamic elements in the audio-visual resources used for the research (Muller et al., 2008; Chi et al., 2017; Ding et al., 2021).

The students in the intervention group were significantly more participatory in the session, giving their opinion and evaluating the resources shown in the virtual classroom. Nevertheless, the students in the control group were more passive, intervening less in the virtual classroom (Pirhonen and Rasi, 2017; Karami, 2019; Raj et al., 2019).

In studying the results obtained from the learning control surveys, it is observed that there are statistically significant differences between the intervention group and the control group, which highlight the improvement in the understanding of concepts and ideas handled in the virtual classroom thanks to the use of audio-visual resources (Abdulrahaman et al., 2020; Harrison, 2020; Noetel et al., 2021a).

The findings obtained confirm that the audio-visual resources used in the virtual classroom facilitate learning and the development of skills among the students selected for this research, so its use turns out to be a good teaching strategy (Lagoa et al., 2018; Valls and Oliva, 2020; Torres et al., 2021).

6 Conclusions

The general objective of this research was to study the perceptions of students on the use of audio-visual resources in the subject of didactics of business and its environment, taught in the master's degree in Teacher Training for High School, Vocational Training, and Language Teaching (specialty in economy, business and commerce) at the University of Nebrija. The two research questions posed were:

a   Does the use of audio-visual resources impact the students' learning performance?

b   What are the students' perceptions regarding the use of audio-visual resources in the company didactics classroom and its surroundings?

The experimental method, widely used in research on teaching and learning, was applied to answer the questions raised.

Regarding the first research question, the experiment shows that learning performance is higher in the intervention group than in the control one because of the use of audio-visual resources: the intervention group obtains better scores in the gamified test with Quizizz than the control group, and the Mann-Whitney non-parametric inference test confirms the robustness of this result. In short, the use of audio-visual resources has a positive impact on the learning performance of students.

Concerning the second research question, after formulating an open question for the intervention group students, those recurring words and expressions are identified that reveal a very positive perception of using audio-visual resources in the classroom. Most of the students seem to agree that the audio-visual resources kept their attention, encouraged their participation and interaction, increased their motivation, facilitated their learning in a fun way. Finally, the students considered that using audio-visual resources in the classroom improved their study habits and, consequently, they reached a higher academic performance.

Among the limitations of this study, the following can be pointed out, without being exhaustive:

a   The results are limited to a postgraduate student profile in a specific subject.

b   The behaviour of two unique samples is analysed, being able to design a more complex experiment;

c   The final question to the students of the intervention group could have been replaced by an interview, to combine the quantitative analysis with the qualitative one, integrating both in a mixed approach.

Future lines of research should focus on overcoming the limitations above.

Firstly, future studies should expand the analysis to students from different courses and faculties to identify potential perception discrepancies.

Secondly, future research should consider different training levels like degree and post-degree to determine which training level audio-visual resources are more effective.

Thirdly, reinforce results using larger samples.

Finally, and fourthly, combine a mixed methodology of the QUAN → qual type: a sequential analysis scheme that focuses on the quantitative perspective to guide later qualitative work.

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