

Exploring learning congruence and the availability of diverse educational resources: A study conducted in the field of management education

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ABSTRACT

Teaching innovation entails constantly adapting to evolving learning environments and diverse audiences. University educators have generated a plethora of materials to accommodate various modes of instruction, such as distance learning, blended learning, or synchronous and asynchronous teaching systems, facing a multitude of learning profiles and study techniques in a classroom. This diversity led us to propose the same content from a business administration course in different formats: text-based, graphics-based and audio-based materials. The use of different materials is attractive for students because of their novelty, but lecturers are unaware of their effectiveness in their learning outcomes. In order to explore these implications in management education, this research aims at finding out whether the availability of various types of educational materials in a business administration course and the congruence between declared learning preferences and the type of material received influences students' learning outcomes. The results of an experiment carried out on 253 first-year students of the course Introduction to Business Economics show, in line with other studies, that the relationship is not direct but that having a variety of materials available is more responsive to the reality of the student body and increases satisfaction and active learning.

1. Introduction

Understanding diverse learning profiles is of great importance for lecturers who want to create effective and inclusive learning environments. Each student in Higher Education Institutions (HEI) brings unique preferences and ways of processing information, and recognizing and addressing these individual learning profiles can significantly enhance the educational experience and promote better learning outcomes.

In the traditional approach to education, a one-size-fits-all teaching style dominates classrooms, being the lecture the primary method of instruction (Lammers & Murphy, 2002). This means that little consideration is given to the varying needs and learning styles of students (Vickerman, 2009). In addition, this conventional approach to teaching has persistently been applied even in virtual education settings, prompting more and more studies to advocate for a combination of face-to-face methods with online teaching in a blended learning approach, in order to adapt to student diversity (Snowball, 2014). At the same time, many other lecturers in universities have turned their teaching style around, spurred by pressures from other institutions providing alternative options specifically

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designed for nontraditional or older adults (Hoyt & Allred, 2008), so that they are beginning to offer more innovative systems that adapt to the profile and circumstances of students. In fact, student-centered learning environments have received more attention (Deng et al., 2022; Samah et al., 2011; Stoten, 2020) and there are many experiences reported in the field of management that advocate more personalized learning (Jääskä et al., 2021; Lew & Saville, 2021). By acknowledging and addressing students' circumstances, HEI can foster a more engaging and tailored learning experience (Anbarasi et al., 2015; Ismaeel & Al Mulhim, 2019).

From the learner's point of view, recent studies such as Jovanovic et al. (2017) note that students often lack skills and proficiency to adapt to new learning environments, employing learning strategies that are not optimal for them (Winne & Jamieson-Noel, 2003). That is why providing different tools and material options can enable them to develop other skills and competencies and manage their attentional resources (Valentine et al., 2017).

Despite the belief that responding to different learning preferences results in better learning outcomes (LO), the truth is that the relationship between learning preferences, learning styles and learning outcomes is intricate and not straightforward, as evidenced by research (Nancekivell et al., 2020). The complexity arises from the challenging task of capturing and measuring the cognitive processes involved. Some authors, such as Deng et al. (2022), even qualify this type of analysis as futile, and there is even a stream of researches categorized as *the terminators* who advocate the end of style research (Peterson et al., 2009). However, they acknowledge a relative scarcity of studies in the field of management, indicating a gap in research. Consequently, this contribution seeks to advance knowledge in this area, aiming to move beyond the unproductive examination of relationships among variables. Specifically, our focus is on the aspects of availability and consistency with *declared* learning preferences. We believe that delving into these dimensions will provide a more nuanced understanding of a classroom reality. In recent academic years, our efforts to update materials have focused on providing diverse approaches to concepts for facilitating learning. Regrettably, we have not been able to assess whether the availability of these materials genuinely influences learning outcomes and how students evaluate the materials in accordance with their learning profiles. With a twofold objective, this study address this gap. First, it aims to explore how students perceive, engage with and manage various formats of learning materials provided by lecturers in business teaching, evaluating the effectiveness of having different typologies (text, visual, audio). Second, by exploring the effect of congruence between declared learning preferences and learning outcomes, this research seeks to gain valuable insights into the effectiveness of different instructional approaches.

The structure of the paper is as follows. First, a theoretical framework is established and the research questions are posed. Subsequently, the research methodology is explained, describing the context of the study and the analyses carried out. After explaining the results, the conclusion and discussion are presented.

Table 1
Conceptual models of learning styles. Source: Adapted from Coffield et al. (2004).

Year	Model	Descriptors	Measure
1996	Allinson and Hayes' Cognitive Styles Index (CSI)	Analysis type Intuition	38-items
1998	Apter's Motivational Style Profile (MSP)	Means-ends domain (Achievement Serious – Fun Playful) Rules domain (Fitting in Conforming – Freedom Challenging) Transactions domain (Power Competitive – Love Affectionate) Relationships domain (Individuation Self-Oriented – Transcendence Other-oriented)	Individual rating on a six-point scale
1979 to 2003	Dunn and Dunn model (1978) and instruments of learning styles	Environmental – Emotional – Sociological - Physical - Psychological	Self-report instruments
2000	Entwistle's Approaches and Study Skills Inventory for Students (ASSIST)	Deep approach - Surface approach - Strategic approach	66-item questionnaire
1996	Felder and Silverman Index of Learning Styles (ILS)	Active/Reflective - Visual/Verbal - Sensing/Intuitive - Sequential/Global	44-items
1977	Gregorc's Mind Styles Model and Style Delineator (GSD)	Concrete sequential (CS), Abstract sequential (AS), abstract random (AR), Concrete Random Learning (CR)	10-item questionnaire
1995	Herrmann's Brain Dominance Instrument (HBDI)	Theorists – Organisers – Innovators - Humanitarians	120-items
1982	Honey and Mumford's Learning Styles Questionnaire (LSQ)	Activists – Reflectors – Theorists - Pragmatists	80-items
2002	Jackson's Learning Styles Profiler (LSP)	Initiator – Reasoner – Analyst - Implementer	80-items
1976 to 1999	Kolb's Learning Style Inventory (LSI)	Active experimentation - Concrete experience - Abstract conceptualization - Reflective observation	Scores based on completion of 12 sentences
1962	Myers-Briggs Type Indicator (MBTI)	Extraversion/Introversion - Sensing (S)/Intuition (N) -Thinking (T)/Feeling (F) - Judging (J)/Perceiving (P)	50-item, 93-item, 126-item questionnaires
1991	Riding's Cognitive Styles Analysis (CSA)	Cognitive organization dimension (holist-analytic) Mental representation dimension (verbal-imagery)	Cognitive tasks
1998	Sternberg's theory of thinking styles and his Thinking Styles Inventory (TSI)	Legislative – Monarchic Executive – Hierarchic - Judicial – Oligarchic – Anarchic Global – Local – Internal – External -Liberal – Conservative	13 inventories with 8 statements (1–7 scale)
1992	VARK learning styles	Visual - Auditory - Reader/writer - Kinesthetic	16-items
1996	Vermunt's Inventory of Learning Styles (ILS).	Meaning-directed - Application-directed - Reproduction-directed - Undirected	120-item self-rating instrument (5-point Likert scales)

2. Background and research questions

The relationship among learning preferences, learning styles, learning strategies, and learning outcomes is complex and interconnected (Deng et al., 2022; Jie & Xiaoqing, 2006; Nancekivell et al., 2020; Shi, 2011). Understanding how these factors influence each other can significantly affect the effectiveness of educational strategies and improve learning experiences.

Learning preferences refer to the different ways in which students prefer to receive and process information, showing individuals' specific tendencies when it comes to acquiring knowledge. However, the preference when learning emerged with Gibson (1969) as the construct learning style (Borrás-Gene et al., 2022). These statements, however, mix two concepts that we can differentiate. On the one hand, the preference for receiving information could be isolated as a learning preference, or existence of study preference, as proposed by Pashler et al. (2008). On the other hand, the way in which information is processed, which has to do with internal factors, can be understood as a learning style. Preferences may align with particular learning styles or extend beyond them. That is, a learner may have a dominant learning style but may also select a combination of learning preferences depending on their life stage, the age group, gender, cultural values, the content delivered, or the situation (Borun et al., 2010; Holtbrügge & Mohr, 2010). This means that although they are usually stable, learning styles and preferences evolve and are conditioned by personality or the environment (Nancekivell et al., 2020).

Once students receive the information (which may or may not be congruent with their current preferences or their learning style), they can adapt it to their learning preference through certain strategies of study. Thus, learning strategies are considered as the way students prefer to assimilate new information, incorporating consistently adopted approaches to learning (Kolb, 1984). That is, the learner will converge the information received into his/her preferred style through learning strategies (e.g. visualizing the information received in text, textualizing the information received in audio, making diagrams, repeating the information aloud, etc.). More specifically, Macaro (2006) defines learning strategies as “any set of operations, plans or routines used by learners to facilitate the obtaining, retrieval, storage and use of information”.

There are different conceptual models of learning styles in which concepts such as “cognitive styles”, ‘conative styles’, ‘cognitive structures’, ‘thinking styles’, ‘teaching styles’, ‘motivational styles’, ‘learning orientations’ and ‘learning conditions’ (Coffield et al., 2004) are intertwined. If the reader wants to deepen into variables, validity and appropriate use, De Bello (1990) published a comparison of eleven major learning styles and Coffield et al. (2004) published a systematic review of learning styles, categorizing thirteen as major models (see Table 1). Twenty years later, Deng et al. (2022) highlight the lack of knowledge that exists about the interpretation of learning style instruments and their usefulness in management education. The main conceptual models used in business and management are MBTI, LSP, LSQ, CSI and LSI (Coffield et al., 2004; Deng et al., 2022).

Learning styles are considered a concept that include cognitive traits and intellectual and personality characteristics (Sadler-Smith, 1997). However, styles and preferences are often used interchangeably. VARK, for instance, is not consider a learning style by Fleming himself (Fleming, 2012), but “the identification of modalities that they might prefer when learning” (Fleming, 2012). In this sense, it is important to note that a learner's preference for a specific format, based on its past effectiveness, might not necessarily translate well into a different context. This is because learning is influenced by their personal and intellectual circumstances.

Learning strategies are the key that opens the door to adapting the information received to each learners' learning style, being context-specific (Entwistle & Peterson, 2004). Understanding learning profiles in the classroom involves identifying and categorizing different learning styles and preferences among students. Visual learners grasp information more effectively through visual aids such as graphs, charts or diagrams, while auditory learners prefer verbal explanations and discussions. On the other hand, textual learners engage best with text materials, such as notes and written instructions, while kinesthetic learners benefit from hand-on experiences and physical engagement with the topic.

Considering learning strategies as “any thoughts, behaviors, beliefs or emotions that facilitate the acquisition, understanding or later transfer of new knowledge and skills” (Weinstein et al., 2000), they are the link between learning preferences and learning styles; so that learners will try to carry out learning strategies that are in line with their learning styles and preferences (Table 2).

This study aims to explore the impact of the availability of instructional materials and the congruence in learning preferences on individual learning outcomes (LO). These issues have already been explored in fields such as healthcare (Andrade et al., 2015; Husmann & O'Loughlin, 2019; Torgersen & Boe, 2021; Yeh et al., 2016), or science (Gozalo-Delgado et al., 2020; Li et al., 2018) as well as in private universities (Lee et al., 2014). Therefore, we aim to provide more evidence in the field of management in a public university. Studies carried out so far in microeconomics or accounting sciences (Shiu et al., 2020; Visser et al., 2006) explored different instructional materials and other learning styles instruments. We consider that considering other type of evidences and instruments can be positive for social science heuristics.

By recognizing and addressing diverse learning profiles, lecturers in HEI can optimize their teaching strategies and instructional approaches. Using a combination of materials catering to different learning styles and preferences allow for a more comprehensive and well-rounded learning experience (Carlson, 1991; Tulbure, 2011). When students engage with various formats such as text, visuals, and audio, they are challenged to process and integrate information from various sources. This encourages student engagement (Hunt

Table 2
Stages in the learning process. Source: Authors.

Learning preference	Learning strategy	Learning style
Based on past experiences, specific environmental appeals or circumstantial preferences	Related to interaction with materials and how they suit learning styles	Influenced by the learner's personality and intellectual characteristics

et al., 2016), promotes critical thinking (Djamas & Tinedi, 2021), and synthesis of knowledge. Also, the cognitive stimulation provided by this integration of information (Purnell et al., 1991) can lead to improved comprehension of a certain topic, and application of learning to other situations, which can facilitate deeper understanding (Argelagós et al., 2018).

Even when individuals may have certain learning preferences, the use of a variety of instructional methods and materials can benefit all learners (Kauffman, 2015). A diverse range of teaching approaches can provide multiple pathways for students to grasp and internalize information, leading to improved learning outcomes for a broader range of learners (Payaprom & Payaprom, 2020; Serdà & Alsina, 2018). In this sense, learning outcomes are observable changes in knowledge, skills, attitudes and behaviors that results from the learning process and can be measured through assessments, self-reported learning outcomes, examinations, projects, or real-world applications (Caspersen et al., 2014; Crisp, 2012).

When lecturers provide a diverse range of materials, students have the opportunity to connect and interact with them according to their learning preferences at a given time and under a given circumstance, enhancing their learning experience and consequently, having the possibility to obtain better learning outcomes. The selection and management of each available material by students can be explained through the cognitive load theory (CLT), which advocates that effective teaching design should reduce cognitive load and support optimal memory performance (Haryana et al., 2022). The objective of offering different materials, along the line proposed by Shiu et al. (2020) offering animated videos and written text in a laboratory experiment or by Andrade et al. (2015) proposing three multimedia groups, is twofold. On the one hand, the lecturer ensures that all individual learning preferences and styles are covered, but on the other hand, students feel more motivated and engaged in the learning process by having different options aligned to their preferences than can positively affect their outcomes. When students are presented with content that is convergent with their preferred mode of learning (Richmond et al., 2017), they are more likely to process information effectively, retain it for longer period, and apply it to new contexts (Petersen et al., 2020). For this reason, we propose the following hypothesis.

H1. Individual learning outcomes are significantly higher for students who have the three materials (video/image, audio, and text) available comparing to those having only one type of material

Different types of materials engage different senses and have different effects on working memory (Einstein et al., 1990), which can enhance information processing. Graphics can aid in visualizing complex concepts, while audio can reinforce understanding through verbal explanations, debates and discussions. Learning congruence or matching refers to the alignment between the preference of a learner for a learning style or profile and the teaching methods or materials used (Yeh et al., 2016). In literature, this matching is called *meshing hypothesis* when it comes to compare learning and teaching styles, and has already being tested by Ford (1995) with two dimensions of cognitive styles and two teaching materials or Riding and Douglas (1993) in two presentation conditions (text-plus-text and text-plus-picture). When materials or methods are congruent with an individual's learning preference (at a given time, depending on the circumstances/preferences at that time), it means that the materials cater to their preferred mode of processing information in that context (visual, auditory, read/write and kinesthetic, considering VARK learning styles). Responding to preferences at different times allows all types of learners to absorb and process information depending on their context (Neel & Grindem, 2010).

Several factors may contribute to the potential impact of congruence on individual learning outcomes. First, when students are taught in a manner that aligns with their learning preferences in a certain moment, they are more likely to be actively engaged in the learning process (Pheiffer et al., 2005). This better engagement leads to increase motivation and a stronger desire to understand the topic, which can positively influence learning outcomes (Soundariya et al., 2017; Yeh et al., 2016). Secondly, congruent events, in this case congruent learning, accelerates neural encoding mechanisms (Packard et al., 2017) so that the students optimize information processing and minimize cognitive load. That is, visual learners may benefit from visual aids such as figures and diagrams while textual learners may benefit from words, glossaries and explanations. Using congruent learning, learners can capitalize on their preferred modes of information processing, allocating their cognitive resources more effectively and leading to improved comprehension and retention of the topic. Students that receive materials congruent to their learning preferences gain a sense of competence over the topic, leading to increased confidence in one's ability to learn and achieve success. In fact, higher self-efficacy is associated with better learning outcomes (Bassi et al., 2007). On the other hand, incongruent learning experiences may require additional mental effort to adapt to less preferred modes of instruction. The latter, however, can be considered an advantage of mismatching, as it overcomes cognitive barriers by stimulating learning and flexibility (Visser & Vreken, 2006). For all of the above, following the lines of Ford & Chen (2002), we propose the following hypotheses.

H2. Individual learning outcomes in congruent learning experiences (a. declared visual learning preference receiving visual materials, b. declared auditory learning preference receiving audio materials, c. declared textual learning preference receiving text materials) are significantly better than individual learning outcomes in incongruent learning experiences (mismatched conditions).

3. Research methodology

In order to provide a more comprehensive understanding of the availability of materials and the congruence of learning experiences, a mixed-methods approach is used. First, we provide an overview of the participants and the experimental design. Second, we describe data collection and the statistical tests employed to analyze and compare quantitative data.

3.1. Participants and activity design

Freshman students enrolled in the courses Introduction to Business Administration (lectured in the Bachelor's Degree in Business Administration and Management, the Double Degree in Business Administration and Economics, Double Degree in Law and Business

Administration and Management, and Double Degree in Business Administration and Management and Labor Relations in the Faculty of Economics and Business Administration in the University of Cantabria) and in Fundamentals of Business Administration (lectured in the Bachelor's Degree in Labor Relations in the Faculty of Law in the University of Cantabria) participated in the study. A total of 253 valid responses were obtained from the study participants, out of a total of 349 enrolled students (72.3%).

The research followed a structured methodology involving 1) design of the materials, 2) design of the experiment, and 3) implementation of the experiment.

3.1.1. Design of materials

In the initial phase of the project, the focus was on selecting the course content to be presented in three distinct formats: video/image, audio and text. These formats, commonly used by the lecturers during the course, are not used at the same time to lecture the same topic. The aim in this case was to adapt the materials used during the course to different learning preferences, creating adaptable resources for subsequent courses. The selected topic to be taught was a profitability analysis (included in Lesson 6 of the course, Activity Indicators in the Organization), covering concepts such as Return on Assets (ROA), Return on Equity (ROE), Weighted Average Cost of Capital (WACC), Cost of Equity Capital, and their interpretation and comparison.

The text material, comprising a five-page PDF document, included a comprehensive glossary summarizing all concepts (see extract in English in Fig. 1). The visual material featured a 5-min 27-s video, presentation using graphs, tables and images, created with Prezi and later into a mp4 file. The audio component presented a scripted reading of the text-type material (podcast style) lasting 11 min 17 s. All materials were produced in Spanish and made available to students through the Moodle platform, the virtual classroom of the course.

3.1.2. Design and structure of the experiment

In the second phase of the project, the emphasis was on designing and structuring the experiment. Initially, students were asked about their preferences when learning, as well as the assessment of different learning styles. To do this, we briefly explained the concept of learning preference based on the VARK learning preferences and what each of them consisted of (visual, aural, read/write and kinesthetic). This provides us with the student's *declared* learning preferences (see Table 5).

Subsequently, students took the VARK questionnaire on the VARK official website, of the instruments that require greater use in management education (Deng et al., 2022). These results provides us with learning preferences and learning styles (not declared, but obtained through a previously validated test).

With this information, we classify students into sets prior to the development of the activity (Table 3) and then provide them with the materials in different styles. To classify the students, we used the information from VARK questionnaire, so that students with a clear preference (majority of V - visual, majority of A - auditory, majority of R - write/read) were provided with the corresponding associated material (graphics, audio, text, respectively). It is important to emphasize that this criterion is intended to be classificatory, since, as Fleming (2012) point out, "VARK is NOT about matching teaching materials to learning preferences", and in fact, evidence-based literature supports this (Deng et al., 2022). The remaining students were randomly assigned 1) one type of material, 2) three materials at the same time. Another group of students freely chose the type(s) of material they wanted to use.

Hypothesis 1 and 2 are tested by classifying the students from these eight sets into groups, according to the availability of materials and congruence/matching in the learning preference (Table 4). Regarding the availability of materials addressed in H1, it refers to a

Profitability analysis

The profitability analysis is structured into three sections to address three fundamental questions:

- 1 **Is the company's activity profitable?**
- 2 **Is it profitable for its shareholders or owners?**
- 3 **What factors can influence profitability?**

1 **Is the company's activity profitable?**

To analyze this aspect, two ratios need to be calculated: Return on Assets (ROA) and the cost of capital (CC). Subsequently, a comparison between them is necessary.

Return on Assets (ROA)

It measures the relationship between the gross results obtained (EBIT) and the assets employed to achieve them (investments made in current and non-current assets). Economic profitability is the return generated by the company's assets regardless of the means of financing.

$$ROA = \frac{EBIT}{\text{Total Assets}} \cdot 100$$

EBIT: Profit generated by the company's assets before financial expenses and Taxes (T)

Total Assets: Total assets of the company including investments in non-current assets, ATC, and current assets.

Glossary

Return on Assets (ROA): It measures the relationship between the gross results obtained (EBIT) and the assets employed to achieve them (investments made in current and non-current assets).

Return on Equity (ROE): Measures the relationship between the net results obtained after subtracting financial charges and taxes and the company's equity (contributions from partners, share capital, undistributed profits, reserves, and other possible sources of self-financing).

Gross Profit: Profit generated by the company's assets before financial expenses and Taxes.

Total Assets: Represents the total investments of the company, including investments in non-current assets (ATC) and current assets (AC).

Cost of Capital: Weighted average of the cost of different financial sources or resources that the company uses, using the importance (amount) of each source of financing in relation to the total value of net equity plus liabilities as weights or proportions.

Volatility: Difference in the variation of the value of the company or sector compared to the market average. Represents the risk of the company.

Calculating ROA

Consider the following business scenario: you purchase a stamp for €100 and sell it the next day for €120.

What is the profit of the transaction? €20 (120-100)

What is the profitability of the transaction? 20% (20/100)

ROA is calculated as the generated profit divided by the assets:

$$ROA = \frac{EBIT}{\text{Total Assets}} = \frac{20}{100} = 20\%$$

Adapted from: Marín, 2019, p. 218

Fig. 1. Extract of materials in text, translated to English. Source: Authors.

Table 3

Experiment sets according to the learning style and material provided. Source: authors.

Set	VARK result	Material	N.
Set 1	Aural preference (A)	Audio	65
Set 2	Aural & Kinesthetic preference	Visual	21
Set 3	Visual preference (V)	Text	25
Set 4	Visual & Kinesthetic preference	Visual OR Text	51
Set 5	Read/write preference (R)	Aural OR Text	21
Set 6	Read/write & Kinesthetic preference	Aural OR Visual	6
Set 7	Aural & Kinesthetic preference (A&K)	Visual OR audio OR text	34
Set 8	Visual & Kinesthetic preference (V&K)	Visual AND audio AND text	30
Set 9	Read/Write & Kinesthetic preference (R&K)		
Set 10	Random		
Set 11	Random		

Table 4

Groups according to the learning preference and material provided. Source: authors.

Matching	Text material	Audio material	Video material	Three materials	Total
Congruent	28	18	18		64
Incongruent	45	38	24		107
NA	17	19	16	30	82

distinction made among learners who received all types of materials and those who only receive some type of material. [H2](#) focuses on testing whether LO improve when a matching is made between learning preferences and the type of material used, understanding this as congruence or matching. Specifically, if students received the type of material that they declared as preferred, they are considered to be in the “congruent” group, and students who received a different type of material than the one considered as preferred for learning are considered to be in the “incongruent” group.

3.1.3. Implementation of the experiment

Students were informed via the virtual classroom Moodle about an upcoming in-class activity, which contributed to their monitoring mark. They were instructed to bring an electronic device (laptop, tablet, smartphone) and headphones for audiovisual materials (see [Fig. 2](#)). The communication of project objectives by lecturers was deliberately kept minimal to avoid biased results. The session was divided into two main parts: interaction and study of the materials (all of them were interacting with the materials for the first time and no one had received any lecture on the topic in the course), and evaluation. Initially, students engaged with assigned materials through visualizing, reading, or listening for approximately 45 min. To facilitate this, they received and email minutes before the session containing the necessary details such as the folder location on Moodle and the access code. Students who had not completed the previous surveys were randomly assigned during this time. All students were given an equal amount of time, and they independently regulated their interaction time with the materials and study. Following this period, students had the opportunity to complete an evaluation test (20-questions), aiming to assess their knowledge acquisition based on the materials used.

3.2. Analysis

The experiment provided us with two types of variables: 1) variables related to learning styles and preferences, and 2) learning outcomes ([Table 5](#)).

The validation of our research hypothesis involves examining whether significant differences exist in learning outcomes among groups. The first hypothesis ([H1](#)) compares learning outcomes within groups based on the material received (all materials/one type of material), while the second hypothesis ([H2](#)) assesses learning outcomes within groups according to the congruence between their stated preferences and the material received.

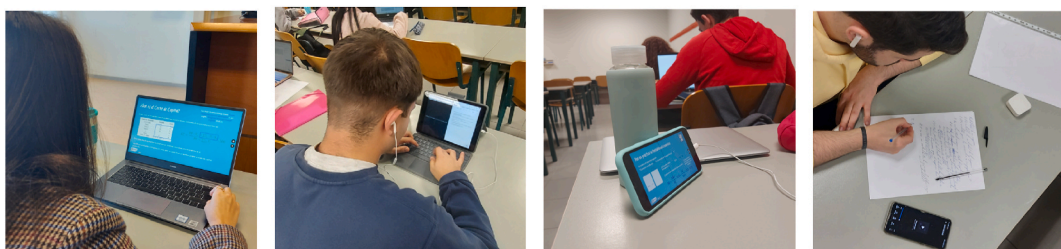
**Fig. 2.** Use of electronic devices during the experiment. Source: authors.

Table 5

Summary of variable explanation. Source: authors.

Type	Variable	Measurement	Values/Scales
Learning styles and preferences	Declared learning preference (DECLARED)	Open question	Preference for visual learning, preference for textual learning, preference for auditory learning
	VARK learning style (VARK)	VARK Questionnaire	Visual preference, Aural preference, Read/write preference, Kinesthetic preference (see https://vark-learn.com/ for others)
	Congruence (CONG)	Coincidence between declared learning preference and type of material	Yes/No
Learning outcomes	Learning outcome (LO)	20-question test	0-10 points

To conduct this analysis, we initially employed the Shapiro-Wilk test, designated to evaluate the normality of a dataset and it is applicable for samples with less than 50 elements (Tapia & Cevallos, 2021). This test provides evidence for appropriateness of parametric tests. When data in groups deviate from the assumption of normality (indicated by a p-value below 0.05), the alternative non-parametric test is more suitable. In this case, Mann-Whitney *U* test (also known as Wilcoxon rank-sum test) in the case of two groups and Kruskal Wallis test in the case of three or more groups determine whether there are statistically significant differences among them. When the results are statistically significant, it is appropriate to conduct Dunn's test to determine exactly which groups are different. All quantitative analyses were executed using R software (R Core Team, 2013).

4. Results

Table 6 presents the demographic characteristics of the participants. Female students accounted for 58.5% of the sample (148 students), while male students comprised 41.5% (105 students). The majority of participants (55.7%) were enrolled in the Degree of Business Economics and Management (BE) at the University of Cantabria, 23.7% in the Labor Relations Degree (LR), and the remaining students (20.4%) were enrolled in Double Degrees (DD BE/LAW, DD E/BE, DD BE/LR).

Results obtained in relation to learning preferences and learning styles perceptions allow us to take a snapshot of the class learning profiles. The students self-identified primarily as visual learners (32.0%) and readers (30.4%), followed by kinesthetic learners (16.2%) and auditory learners (12.2%). Twenty-three students were either unable or unwilling to declare their learning preference (see Table 7).

In addition to being asked to select their preferred learning style, students responded from 1 (I do not learn at all) to 10 (my preferred way of learning) how they learn best (see Table 8). Students assessments are highest for visual learning styles (7.48 out of 10), very similar to the kinesthetic learning style (7.43), followed by the textual learning style (7.10) and finally the auditory learning style (6.50). The results segmented by learning style are not surprising. As expected, students who state that their learning style was visual respond that they learn best with visual elements, and this pattern is followed across all learning styles. For students who declared no learning preference, ratings are less variable and similar to the class average (lower in visual, text and kinesthetic but higher in audio).

Congruence in learning preferences and learning outcomes.

After the time devoted to self-study of the materials, students completed a 20-question evaluation test. The average score for the group was 7.629 out of 10. In general terms, students who had access to visual materials scored higher than those who accessed the text material, followed by those who accessed only the audio material (the average score of students who accessed one type of material was 7.661). Contrary to what might be expected, the students who had access to all types of materials scored lower than the rest (see Fig. 3 and Table 9). Therefore, H1 cannot be accepted. The difference in means was tested using Mann-Whitney *U* test, but it was not statistically significant. In order to increase the robustness of the results, we performed Wilcoxon Two One-Sided Tests (TOST), in which the null hypothesis of equivalence is rejected. Thus, it endorses the lack of statistical evidence to claim that there is significant evidence to claim that there is a significant difference between the two groups being compared. This result may respond to various factors, such as the quality of the materials, the topic selected for the experiment within the course or individual differences among students (for example, prior knowledge or above-average performance).

Table 6

Demographic characteristics of participants. Source: Authors.

Description	Frequency	Percentage (%)
Gender		
Female	148	58.5%
Male	105	41.5%
Degree		
Double Degree BE/LAW	23	9.0%
Double Degree E/BE	9	3.5%
Double Degree BE/LR	20	7.9%
BE	141	55.7%
LR	60	23.7%

Results of the learning preferences and styles.

Table 7

Classification of students by declared profiles. Source: authors.

Declared profiles	Total	Female	Male	DD BE/LAW	DD E/BE	DD BE/LR	BE	LR
Visual	81 (32.0%)	46	35	9	1	9	48	14
Aural	31 (12.2%)	21	10	2	1	4	13	11
Read/write	77 (30.4%)	44	33	8	6	6	41	16
Kinesthetic	41 (16.2%)	21	20	2	1	1	25	12
ND	23 (9.1%)	16	7	2			14	7

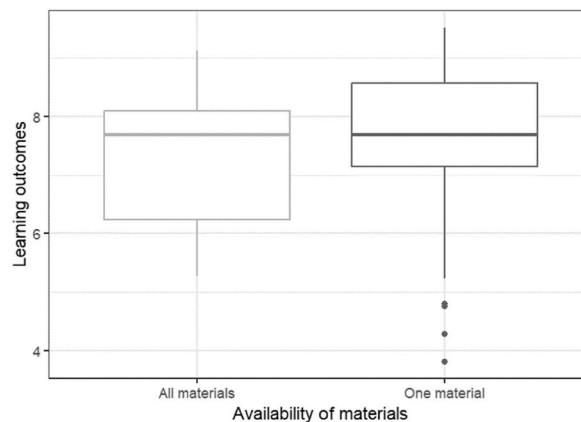
Note. DD BE/LAW: Double Degree in Law and Business Economics and Management, DD E/BE: Double Degree in Business Economics and Management and Economics, DD BE/LR: Double Degree in Labor Relations and Business Economics and Management, BE: Degree in Business Economics and Management, LR: Labor Relations Degree.

Table 8

Declared learning preferences and perception of learning. Source: authors.

Declared profiles	Visual ^a	Audio	Text	Kinesthetic
Visual	8.70	6.44	6.27	7.13
Aural	6.45	9.06	6.71	7.19
Read/write	6.64	5.81	8.90	6.94
Kinesthetic	7.49	5.93	5.98	9.40
ND	7.35	6.55	6.50	7.09
Total	7.48	6.50	7.10	7.44

^a Mean rating from 1 [I do not learn at all] to 10 [my preferred learning style].

**Fig. 3.** Box and whiskers plot of availability of materials and learning outcomes. Source: authors.**Table 9**

Average learning outcomes (0 – lowest mark to 10 – highest mark) by material provided. Results by Degree. Source: authors.

	Group	Visual	Audio	Text	Average one material	Average all materials	p-value
Sample	7,629 ¹	7,780 ¹	7,487 ¹	7,730 ¹	7,661 ¹	7,392 ¹	0,2564

Note: ¹Not normally distributed (Shapiro-Wilk p-value <0.05).

Our second hypothesis posits that students who received learning materials aligned with their declared learning preference (congruent group) would achieve higher LO compared to those in the incongruent group. Students performed better in the congruent group when exposed to audio and text materials, whereas their performance was lower when presented with visual materials. Conversely, those exposed to visual materials achieved higher LO in the incongruent group (see Fig. 4 and Table 10). The p-value of the Kruskal-Wallis test only indicated statistically significant difference among groups in the case of visual materials. Kruskal-Wallis requires additional test to find out between which groups are differences. For this purpose, a multiple comparison with the Dunn test, adjusted with the Bonferroni method. Dunn test in the group of students who received visual materials reflects an adjusted p-value of 0.0295, suggesting that there is a significant difference between matching and unmatching groups after adjusting for multiple comparisons. In this case, it is also observed that LO are the highest, which supports and educational impact comparable to other materials (Shiu et al., 2020). It is possible that the students who did not prefer visual materials as a learning preference had different expectations, such as a recorded lecture-based format. Therefore, receiving graphic-based materials (diagrams, labels, explanatory

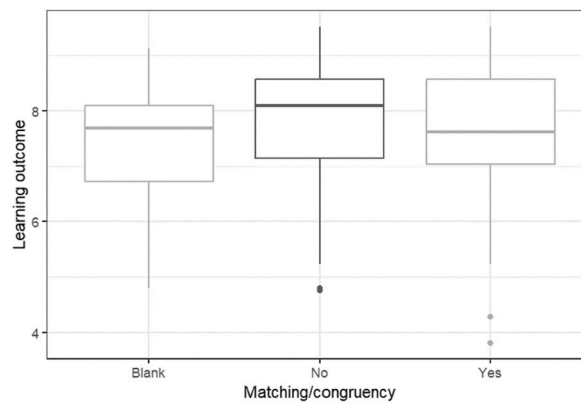


Fig. 4. Box and whiskers plot of matching/congruency and learning outcomes. Source: authors.

Table 10

Average learning outcomes by material provided and congruence/matching with preferred learning. Results by Degree. Source: authors.

	Congruence	Visual	Audio	Text	Group
Sample	Incongruent	8.155 ²	7.490 ²	7.717 ²	7.735 ²
	Congruent	7.683 ¹	7.534 ¹	7.752 ²	7.582 ²
	Blank	7.367 ²	7.435 ¹	7.730 ¹	7.529 ²
	p-value ^a	0,0331	0,8218	0,9003	0,3717

keywords) and relevant content could have improved their outcomes (Torgersen & Boe, 2021). Although previous studies have shown that materials designed taking into account students' different learning styles considerable improved the achievement of the learning outcomes (Mironova et al., 2013), the consensus is that learning styles are not predictors of education achievement (Hosseini et al., 2015).

5. Conclusion and discussion

This research presents the outcomes of a teaching innovation project where a specific content from a business administration course is presented using three different types of materials: text-based, graphics-based and audio-based. The objective is to investigate how students respond to the availability of materials and the delivery of materials in accordance with their declared preferences (matching/mismatching).

The effect of the availability of different materials in learning outcomes is addressed in Hypothesis 1. The lack of significant improvement in learning outcomes despite the availability of all materials may be attributed to multiple reasons, for example, the topic selected for the experiment, student commitment, lecturer supervision, the way in which the content has been displayed in each format or the overall quality of the materials.

Individual differences and the study strategies employed by students can influence the effectiveness of using all materials, as learners have unique learning styles and preferences. While some students may benefit from exposure to multiple materials, others may find it overwhelming or less conducive to their preferred learning preference. In addition, having all the types of materials available did not imply having used all the materials in the experiment, so perhaps there were students who only used those materials that were most congruent with their preferences. This problem was already referenced by Goosen and Steenkamp (2023) who said that "if students only utilize the learning strategies associated with their dominant learning styles, they will only partially develop their decision-making skills". Secondly, contextual factors such as student motivation, environment, time constraints, study habits, and the implementation of other strategies in the process of studying can impact the extent to which student engage with the different types of materials.

Regarding Hypothesis 2, which posits that higher learning outcomes occur when there is congruence or matching between the material used and the stated preference for learning, this is also not confirmed. The contrary nature of this result can be attributed to various reasons. First, stated preference of learning has been used to measure congruence, instead of learning styles. This is one of the novelties of our study, so that one of the main contributions is that our results indicate that students may not know how they learn best. Students may respond according to beliefs of how they believe they learn best (e.g., they may believe they learn best through visuals because they may perceive it as less academic, different, more bearable, etc.) or how they would like to learn best. This lack of understanding may stem from the novelty of the change of system for first-year students, a circumstance that has already been pointed out by other authors (Pownall et al., 2019), what favors the request for more studies in these students who are starting their higher education. Thus, this type of experiments are necessary to favor self-knowledge and the development of self-regulated learning, and when carried out with freshman students, they may influence the student's subsequent performance during the degree as they can implement

“remedial actions” (Goosen & Steenkamp, 2023). While aligning learning methodologies with learners’ preferences may enhance engagement and motivation, other factors can appear during the process that have a negative influence to obtain better learning outcomes. Factors such as the complexity of the topic, the level of effort exerted by the student, or how decisive the result of the evaluation can be, among others, can diminish the effect of using congruent materials. Therefore, it is not only about having/using the material only in the preferred style but the possibility of having it in several types that prevails when planning the teaching/learning experience.

A student’s intrinsic motivation towards learning can vary due to behavioral, emotional and cognitive factors (Thijs & Verkuyten, 2009), often requiring extrinsic motivation from the lecturer. With the objective of favoring student autonomy in their learning strategy, the lecturers, although present in the classroom, did not intervene except of technical questions or problems with the virtual classroom. That is, lecturers did not intervene to advice students on which learning strategies to apply or how many times they had to use the materials, for example. Additionally, the result of the assessment had little impact on the final assessment of the course, potentially contributing to lower student motivation despite the use of innovative materials.

Another determining factor is the influence of student engagement, where higher student engagement is associated with better results (Connell et al., 1994). According to authors like Fredricks et al. (2004), engaged students exhibit more effort, experience more positive emotions and pay more attention in the classroom. According to academic literature, greater engagement could have been achieved if the lecturer had taken a more active role, providing confidence, pedagogical guidance and emotional support (Bandura et al., 1999; Martin, 2006; Wittmann & Wulf, 2023). Although we believe that, in our case, the lecturer’s intervention might have interfered with the student’s self-study strategies, the instructor’s attitude is crucial in guiding the student’s decision-making in the teaching-learning process (Wittmann & Wulf, 2023). It can help overcome some of the previously mentioned issues related to the selection and use of materials, and the development of appropriate learning strategies; providing feedback and being sensitive to students’ reactions (Guo & Ro, 2008). The commitment would perhaps have been greater if the student had carried out the activity with peers, since the level of commitment in a group activity when peer support is encouraged is also greater (Clements et al., 2014).

Therefore, according to the results obtained regarding the availability of educational materials (one type or all types), and regarding the congruence between the student’s preference and their LO, this work represents a relevant contribution to the previous literature, since most of previous research has been conducted mainly in scientific or healthcare setting and on smaller samples. Our research applies to more than 250 first-year students of a business course at a public university, contributing to research in social sciences.

One of the limitations in this study is having used learning style models for classificatory purposes. Deng et al. (2022) themselves comment that despite being instruments used by management researchers, their more recent use means that there is less knowledge about them. So on the other hand, this study increases the heuristics of management learning research. In addition, introducing for the first time the concepts of availability and congruence (between declared preferences and materials) significantly reduces the generalization of results, given the inherent nature of declared preference, as it is influenced by the specific circumstances and context of the student. In any case, future research, especially in first-year students, is essential to promote inclusivity and self-knowledge in education, fostering adaptation to diversity.

While the results obtained have not been as expected, as endorsed in other studies with contrasting results (Moser & Zumbach, 2018), the levels of satisfaction and the responses of the students indicate that the development of diverse materials tailored to different learning profiles in a classroom recognized and respects the diverse ways in which students engage with and process information. Additionally, we address potential barriers to learning that students with specific profiles may encounter, providing equal opportunities for all students.

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CRediT authorship contribution statement

Elisa Baraibar-Diez: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **María D. Odriozola:** Writing – review & editing, Visualization, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Ignacio Llorente:** Writing – review & editing, Visualization, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Data availability

Data will be made available on request.

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