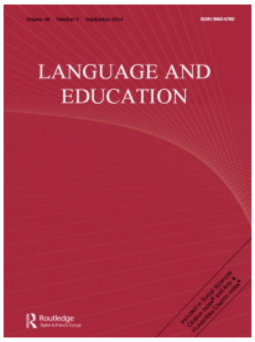


Routledge
Taylor & Francis Group

Language and Education

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/rlae20

# PowerPoint presentations in L1-medium and English-medium lectures: examining knowledge-building practices in multimodal slide content

**Flor de Lis González-Mujico & David Lasagabaster**

**To cite this article:** Flor de Lis González-Mujico & David Lasagabaster (29 Apr 2024): PowerPoint presentations in L1-medium and English-medium lectures: examining knowledge-building practices in multimodal slide content, Language and Education, DOI: 10.1080/09500782.2024.2346527

**To link to this article:** https://doi.org/10.1080/09500782.2024.2346527

Published online: 29 Apr 2024.

LANGUAGE AND EDUCATION
https://doi.org/10.1080/09500782.2024.2346527



# PowerPoint presentations in L1-medium and English-medium lectures: examining knowledge-building practices in multimodal slide content

Flor de Lis González-Mujico[a] and David Lasagabaster[b]

[a]UPV/EHU, Faculty of Arts, English, German, Translation and Interpretation Studies, Centro Investigación Micaela Portilla, University of the Basque Country, Vitoria-Gasteiz, Álava, Spain; [b]UPV/EHU, Faculty of Arts, English, German, Translation and Interpretation Studies, University of the Basque Country, Vitoria-Gasteiz, Álava, Spain

**ABSTRACT**

Research on the effectivity of PowerPoint presentations as an adjunct to theoretical and practical content during university lectures has garnered significant yet inconclusive findings. Specifically, how multimodal academic content should be organised to aid communication remains unclear. Legitimation Code Theory (LCT) introduces the concept of 'semantic waves' as an effective means to understand cumulative knowledge-building practices by modelling how forms of academic content are unpacked and repacked to facilitate understanding. This study applied 'semantic waves' to better understand how academic knowledge is constructed in multimodal PowerPoint presentations and whether differences exist based on discipline, language of instruction and modes used. Seventy-two lectures from subjects taught in the L1 and English-medium instruction were examined across four disciplines at two Spanish universities. Results showed that slide content in the soft sciences developed semantic waves to a greater extent, particularly in L1 Arts & Humanities lectures. Limiting slide content to the combination of text and graphics appeared to constrain scaffolding strategies in the process of meaning-making, while video content was linked to semantic waving. Finally, some pedagogical implications based on these results are presented.

**ARTICLE HISTORY**
Received 22 November 2023
Accepted 16 April 2024

**KEYWORDS**
English-medium instruction (EMI); ICT skills; multimodality; PowerPoint presentations; semantic waves

## 1. Introduction

Since the emergence of information and communication technologies (ICT), the use of PowerPoint presentations as an adjunct to theoretical and practical content has incremented among university teachers (León and García-Martínez 2021). However, the way in which PowerPoint is used and the form it takes has been shown to differ greatly among teachers, between faculties (León and García-Martínez 2021) and based on the language of instruction (Bolton and Kuteeva 2012). Although these concerns have been addressed in several

**CONTACT** Flor de Lis González-Mujico flordelis.gonzalez@ehu.eus UPV/EHU, Faculty of Arts, English, German, Translation and Interpretation Studies, Centro Investigación Micaela Portilla, University of the Basque Country, Justo Vélez de Elorriaga Kalea, 1, 01006 Vitoria-Gasteiz, Álava, Spain.

educational studies (e.g. Cosgun Ögeyik 2017; LeFebvre et al. 2022), findings remain inconclusive. More importantly, how multimodal academic content should be conveyed in PowerPoint presentations to ascertain pedagogical effectivity remains unclear. The fact that students continue to be uniformly in favour of slide content being used in lectures (Cosgun Ögeyik 2017; Dandekar et al. 2017) and that students who prioritise PowerPoint slides may not retain important information in oral explanations (Wecker 2012) make slide content a relevant issue. In addition, the evident surge of English-medium instruction (EMI) in university degree programmes (Lasagabaster and Doiz 2021) foregrounds the need to examine PowerPoint content from a multilingual perspective.

PowerPoint presentations facilitate the creation of multimodal texts that can combine writing, image, sound, and other modes. When used as a teaching resource, it is always the teacher who decides on how multiple modes (i.e. text and/or graphics and/or audio) are composed to make meaning (Bezemer and Jewitt 2018). For multimodal instruction to be effective it needs to be underpinned by research-based principles of how people learn (Mayer 2014, 155). Cumulative knowledge-building learning practices enable students to build on previous understandings and transfer what they learn into future contexts. In this vein, Legitimation Code Theory (LCT) is a sociological framework that can be applied to explore and improve cumulative knowledge-building learning practices in academic settings (Maton 2014), with recent interest burgeoning in EMI contexts (e.g. Argüelles-Álvarez and Morton 2023; Bozbiyik and Morton, 2023a, 2023b).

Drawing on Bernstein's 'code theory' (2000) and Bourdieu's 'field theory' (Johnson and Bourdieu 1993), LCT's principal goal is the analysis of the organising principles that shape and change the production and reproduction of knowledge in educational fields (Clarence 2016a, 5). Specifically, the dimension of Semantics from the LCT framework (see Maton 2013, 2014) can be used to understand how the complexity of meaning and its embeddedness in context are linked in meaning-making. Through it, we can explore the kinds of pedagogy that enable and constrain cumulative learning when using teaching resources such as PowerPoint. The dimension of Semantics analyses how teaching and learning are enacted in any given subject through recurrent movements between simpler and more complex, and concrete and abstract forms of academic content, conceptualized as semantic codes that comprise strengths of *semantic gravity* (SG) and *semantic density* (SD). SG refers to the degree to which the meaning relates to a context: the more meaning relies on its local reference, the stronger it is, whereas the more decontextualised and abstract the meaning, the weaker it becomes. SD refers to the complexity in meaning of a concept, word or phrase: stronger SD indicates that a symbol or term has a greater concentration of meanings condensed into it and may need to be further unpacked for non-experts to understand; weak SD implies that the meaning of a symbol or term is less complex and more transparent and, therefore, easily understood by non-experts without having to break it down further (Maton 2013).

By tracing the strengths of SG and SD over time, we can generate a semantic profile and an associated semantic range that illustrates how subject-content knowledge (i.e. concepts and theories) is unpacked and repacked in PowerPoint presentations. Recurrent shifts between unpacking (downward shift in the semantic profile) and repacking (upward shift), referred to as 'semantic waves', have been shown to be conducive to enabling learners to build their mastery of a subject (e.g. Curzon et al. 2020; Maton 2019). A semantic wave structure can be achieved when abstract language and technical concepts that need to be covered are unpacked using concrete contexts and simpler language, and these ideas are then repacked again by linking them back to the abstract concepts and technical language students need to master. In effect, unpacking is when abstract ideas are linked to concrete examples, and complex knowledge is broken down into component ideas, expressed in everyday language. Repacking is where the concrete, simpler knowledge is connected back to the more abstract and technical knowledge (Curzon et al. 2020; Maton 2019). In contrast, semantic profiles that remain more static, either because academic content involves only abstract concepts or dense meaning, focusses solely on simpler knowledge using everyday language, or includes no repacking of knowledge back to the abstract once a concept has been unpacked, are considered less favourable for students' knowledge-building practices (Curzon et al. 2020, 2).

Airey (2020) argues that disciplines have their own specialist discourses that students need to master. Although studies (e.g. Argüelles-Álvarez and Morton 2023; Mouton 2020) have applied semantic profiling to determine how to improve learning through disciplinary knowledge construction at university, PowerPoint presentations have not been examined. This study applied 'semantic waves' to better understand how knowledge is constructed in multimodal PowerPoint presentations used in undergraduate courses and whether differences exist based on discipline and language of instruction, as noted in previous studies (e.g. Bolton and Kuteeva 2012; León and García-Martínez 2021). Seventy-two lectures from four disciplines (Arts & Humanities; Sciences; Social & Legal Sciences; Architecture & Engineering) were recorded and examined in relation to subjects taught in the L1 and EMI at two Spanish universities. Given the digital nature of PowerPoint, the European Framework for the Digital Competence of Educators (DigCompEdu) was used as a starting point to measure the impact of lecturers' perceived ICT skills on the development of semantic waves. In the remaining sections, this paper provides a brief literature limning the research questions. After which, the objectives and methods of our study are outlined. In the results section, we highlight the significant data garnered upon statistical analysis, prompting a discussion on the implications of our findings. Finally, we conclude with some pedagogical implications and recommendations for future research.

## 2. Literature review

### *2.1. Knowledge construction*

One of the objectives of multimodality is to analyse how teachers choose different semiotic resources (e.g. verbal, visual, aural, spatial), in terms of their meaning potential and how they function, to communicate in university classes. Multimodal research aims to explore how different modes contribute and interact with each other in the same communicative event (Fortanet-Gómez and Crawford Camiciottoli 2015). In the context of EMI, Morell (2018) defends that teacher training courses should include the development of multimodal competence (i.e. the ability to understand the combined potential of these modes for making and eliciting meaning).

Visuals in presentations are considered a major resource for meaning-making since they include a combination of modes wherein meaning is distributed across all the modes (Jurado 2015). So far, studies (e.g. Bernad-Mechó and Fortanet-Gómez 2017; Morell et al. 2020; Querol-Julián 2023) have shown that EMI instructors use and combine content on the screen with other semiotic resources such as questioning practices or non-verbal language to construct meaning. What remains unexamined is slide content as a multimodal semiotic resource *per se*. While Bernad-Mechó and Fortanet-Gómez (2017) noted that references to slides during spoken discourse were clearly higher when lectures were in English in comparison to Spanish, Morell et al. (2020) concluded that further examination of visuals and the multimodal discourse of specific disciplines is needed to determine if there are differences regarding the construction of meaning. LCT Semantics could serve to establish connections between EMI lecturers' disciplinary knowledge building practices and the semiotic resources used to enact them.

For over 20 years educational research has highlighted the significance of disciplinary differences when it comes to the construction of academic knowledge (Kuteeva and Airey 2014). Becher (1989) classified disciplines according to four major categories: 'pure hard' (e.g. physics or chemistry), 'pure soft' (e.g. history or anthropology), 'applied hard' (e.g. engineering) and 'applied soft' (e.g. education). From an EMI perspective, Airey (2020, 7) extols that EMI research be driven by disciplinary rather than linguistic interests if we want content lecturers to consider language seriously. Although slide content has not been tackled, Argüelles-Álvarez and Morton (2023) applied LCT Semantics to examine disciplinary knowledge construction in EMI lecturers in an applied hard sciences context. Semantic profiles highlighted subtle variations and patterns in the classroom discourse of two lecturers teaching the same subject (i.e. applied computing) at undergraduate and postgraduate levels. Both lecturers strengthened SG by embedding knowledge in specific contexts, albeit using difference strategies. In terms of SD, however, the introductory course for non-experts at postgraduate level tried to reduce complexity, while the third-year undergraduate module on telecommunications covered many technical terms, which escalated complexity in meaning. In their recommendations, the authors encourage the need for modelling and demonstration of processes with the use of everyday language to facilitate students' appropriation at a practical level of computer applications, particularly in the final years of undergraduate study. The examination of disciplinary knowledge construction across similar subjects from the same level of tertiary education is still needed, however.

In the pure soft sciences, but in an EAP (English for Academic Purposes) context, Kirk (2017) implemented semantic profiling to facilitate a shift toward the realisation of disciplinary expectations in writing reflections among anthropology postgraduates. Students were shown how a selection of reflections and insights could be visualised as movements between relatively context-dependent meanings (SG+) through more generalised and abstract meanings less dependent on a particular context (SG-). Reporting a highly positive impact, the intervention observed how students immediately reworked drafts after attending each session, armed with a practical means of reanalysing their own writing. Beyond EMI but still in the context of higher education, in the pure hard sciences, Cranwell and Whiteside (2020) found that university teachers exhibited a flatter semantic profile than high school teachers regarding the complexity of spoken-language explanations. While SD remained stronger regardless of context (i.e. symbols or terms needed to be further unpacked for non-experts, with a similar complexity of chemistry-specific vocabulary being used by all teachers), SG was more decontextualised and abstract in tertiary education. Mouton (2020) intentionally steered first-year biology students towards creating semantic movement during their presentations. Stronger students displayed a wider semantic range to address certain questions and showed a better understanding of why this was necessary. In the soft applied sciences, Clarence (2016b) reported that a certain degree of unpacking and repacking was required to enable foundational first-year law students to learn challenging core concepts cumulatively over a course semester.

### 2.2. PowerPoint use

Generally referred to as ICT literacy, one of the key competences of any 21st century educator is the ability to adopt, adapt and use information in a variety of digital contexts (Cabero-Almenara et al. 2021). ICT literacy has been linked to lecturers' PowerPoint presentation skills (e.g. Amua-Sekyi and Asare 2016; Santos et al. 2022). Although educators know to use ICT tools such as PowerPoint, they do not take full advantage of them. The successful integration of these tools depends on the ability to merge technology in new pedagogies that incorporate visual and/or auditory media (i.e. ICT literacy skills), which varies significantly across disciplines (e.g. Cabero-Almenara et al. 2021; Sánchez-Caballé and Esteve-Mon 2022; Sánchez et al. 2021), the sciences reporting lower scores than those in the Arts & Humanities, Social & Legal Sciences and Architecture & Engineering. The use of lecturers' own perception to determine skill competency in these previous studies, however, is a limitation which this study intends to address supporting self-reported data with demonstrated performance.

An additional concern is that findings do not confirm that PowerPoint presentations improve academic outcomes despite students' positive attitudes towards slide content (e.g. Baker et al. 2018). To uncover the characteristics that make PowerPoint a useful tool, scholars (e.g. Baker et al. 2018; León and García-Martínez 2021; Roberts 2017) insist that we need to understand how different modes are embedded to make meaning (Bezemer and Jewitt 2018). Although the combination of modes through pictures, mental imagery, and verbal elaboration in one medium may support learning, there is also a limit to the amount of information each student can process at any one time (Lewis 2016). PowerPoint may create difficulties for students to figure out the given information due to cognitive capacity overload. Regardless of discipline, students in a study by Roberts (2017) felt that multimodal lectures were effective when they resembled a form of storytelling. When the spoken word, text and images simply replicated each other this forced a choice as cognitive demands exceeded students' processing capacities. Students were unsure as to which mode to focus on and found slides that favoured a text-centric approach extremely counterproductive. It is at this stage when semantic waves could aid the narration of academic content.

In relation to whether certain modes are more effective than others, despite students' preference for image-based slide provision (e.g. Johnson and Christensen 2011), only when these were relevant and supported text-based information did they report superior learning outcomes (e.g. Hallewell and Lackovic 2017). Additionally, Baker et al. (2018) found that progressively displaying figures or images (i.e. videos or animations) facilitated more retention. Not only do lecturers need to choose their images meticulously, but they also need to consider how these graphics are used in meaningful ways during instruction to represent conceptual information and guide students' attention. However, examining modes in opposition fails to disclose multimodal meaning-making practices in presentations. The application of semantic waves may be a more fruitful line of scholarship to pursue as it can show how modes represent conceptual information within and across slides.

The impact of EMI on PowerPoint content has also generated interest, yet the results are far from being conclusive. Velilla-Sánchez (2021) found that EMI interlocutors exploited many more resources in communication and meaning construction. Slides in EMI lectures had more occurrences of *code-switching* to help make the lectures easier to follow than those used in the L1-medium taught group. In a study by Jiang et al. (2016), meaning construction and transmission was supported with written prompts that served to eliminate non-comprehension due to language proficiency issues. Similarly, Alkash and Al-Dersi (2013) observed that Powerpoint presentations helped English Foreign Language student-teachers overcome language barriers to grasp and understand the main concepts and theories in this subject more easily. In contrast, Cosgun Ögeyik (2017) noted PowerPoint to be less effective than conventional lectures on English student-teachers' achievement in pedagogical content knowledge, while Bolton and Kuteeva (2012) reported very diverse patterns of disciplinary EMI-language use.

In sum, the literature reinforces the need to unravel how conceptual knowledge is represented in PowerPoint presentations for it to be effectual. Although the findings on semantic waves elucidate upon how scaffolding strategies to steer semantic movement through modelling can be implemented to improve knowledge-building practices at university level, the general trend has been to focus on one single discipline and mode. Based on the above findings, and in order to advance the fields of multimodality and semantic waves research within higher education, this study provides a comprehensive view of how modes in combination represent knowledge-building practices in PowerPoint presentations across disciplines and teaching practices in different languages (i.e. L1 Spanish/Asturian and EMI) and aims to answer the following two questions:

- **RQ1**: What is the impact of perceived ICT skills on the range of semantic codes developed in PowerPoint presentations?
- **RQ2**: How are semantic codes and waves developed in PowerPoint presentations across disciplines and in different languages of instruction?

## 3. Methods

To enhance the validity of our findings and mitigate research biases, mixed methods and triangulation were applied in the current study. A survey was used to gauge participants' perceived level of ICT competence and quantitative observation was employed to identify semantic codes and modes (i.e. knowledge construction practices) in slide content during lectures recorded. First, statistical analyses (i.e. normality tests, Spearman's Rank, Kruskal–Wallis, and Wilcoxon Signed Rank tests) were conducted to identify significant patterns between the overall number of semantic codes participants demonstrated in PowerPoint presentations and perceived level of ICT competence, disciplinarity and language of instruction variance. To gain a more nuanced understanding of lecturers' meaning-making practices, quantitative trends were triangulated with qualitative semantic profiling and multimodal analysis (i.e. the combination of modes used in slide content).

### *3.1. Participants*

To recruit participants for our study, lecturers from four disciplines (i.e. Arts & Humanities, Social & Legal Sciences, Sciences, Architecture & Engineering) within bilingual undergraduate degree programmes at two Spanish universities, which the first researcher of this study had access to, were contacted. A total of 20 lecturers from these four fields of knowledge were willing to participate, which included EMI (9) and L1 Spanish/Asturian (11) lecturers from the same undergraduate degree and year. The participants could be regarded as experienced teachers. The majority (75%) had been teaching for over 10 years (40% for over 20 years) and 25% had been teaching between 6 and 10 years. Most participants (75%) had more than 10 years' experience using ICTs in their teaching. Table 1 shows the distribution in percentages of several demographic variables occupied by each lecturer based on language of instruction.

### 3.2. Instruments

The European Union's Digital Competence Framework for Educators (DigcompEdu) self-assessment tool (Redecker 2017), validated in numerous studies (e.g. Cabero-Almenara et al. 2021; Ghomi and Redecker 2019; Mora-Cantallops et al. 2022), was used to measure lecturers' perceived ICT skills. The questionnaire was presented in Spanish and English via the online survey application Encuestafacil.com (EasyGoingSurvey.com) and included seven areas of ICT competence (see Appendix): A1 Professional Engagement (4 items); A2 Digital Resources (3 items); A3 Teaching and Learning (4 items); A4 Assessment (3 items); A5 Empowering Learners (3 items); A6 Facilitating Learners' Digital Competence (5 items); A7 Open Education (3 items). As per the DigCompEdu framework, all items were scaled from 0 to 7 points, ranging from levels Newcomer (A1), Explorer (A2), Integrator (B1), Expert (B2), Leader (C1) to Pioneer (C2). Level 0 is applied to situations in which lecturers have no competence in that domain. In addition, 18 items were included to collect background data on participants' age, gender, and use of technology in a range of personal, professional, and linguistic contexts.

A total of 72 lectures were video recorded over the course of the first semester in 2022, which provided a total of 88 hours of academic content (L1 = 49 hours; EMI = 39 hours). Recordings captured PowerPoint presentations and verbatim classroom discourse during lectures, which were later transcribed and coded by the first author of

**Table 1.** Description of the participants.

| | Discipline | Gender | Age | English level | Years teaching | Years ICTs |
|---|---|---|---|---|---|---|
| EMI (n = 9) | Arts & Humanities = 2<br>Sciences = 2<br>Social & Legal Sciences = 3<br>Architecture & Engineering = 2 | 56% Male<br>44% Female | 44.5% 40–49<br>44.5% 50–60<br>11% 60+ | 11% B1<br>11% B2<br>33% C1<br>45% C2 | 11% 6–10<br>22% 11–15<br>11% 16–20<br>56% 20+ | 56% 10–14<br>22% 15–19<br>22% 20+ |
| L1 (n = 11) | Arts & Humanities = 2<br>Sciences = 1<br>Social & Legal Sciences = 5<br>Architecture & Engineering = 3 | 55% Male<br>45% Female | 18% 30–39<br>37% 40–49<br>27% 50–60<br>18% 60+ | 9% A2<br>18% B1<br>37% B2<br>27% C1<br>9% C2 | 37% 6–10<br>27% 11–15<br>9% 16–20<br>27% 20+ | 45% 6–9<br>37% 10–14<br>18% 20+ |
| Total (n = 20) | Arts & Humanities = 4<br>Sciences = 3<br>Social & Legal Sciences = 8<br>Architecture & Engineering = 5 | 55% Male<br>45% Female | 10% 30–39<br>40% 40–49<br>35% 50–60<br>15% 60+ | 5% A2<br>15% B1<br>25% B2<br>30% C1<br>25% C2 | 25% 6–10<br>25% 11–15<br>10% 16–20<br>40% 20+ | 25% 6–9<br>45% 10–14<br>10% 15–19<br>20% 20+ |

this study. Maton's (2013) semantic codes were used to analyse content in PowerPoint presentations. The concepts of SG and SD were applied to measure the degree to which slide content was dependent on context (SG) and the degree to which meaning in content was condensed (SD). The continua of strengths of SG and SD density were measured as axes of a semantic plane (see Figure 1) with four principal modalities: *rhizomatic codes* (SG−, SD+); *prosaic codes* (SG+, SD−); *rarefied codes* (SG−, SD−); and *worldly codes* (SG+, SD+). When content represented knowledge that was firmly grounded in a specific context, perhaps with examples from everyday life, or an artifact or visual present in the physical surroundings, it was coded as having strong semantic gravity (SG+). Content that included knowledge that was more abstract and removed from any specific context was coded as having weaker semantic gravity (SG-). Ideas, concepts, texts, or visuals that were highly condensed or 'packed' with meaning in content (i.e. very technical and would need to be 'unpacked' for non-experts) were coded as having high semantic density (SD+). When meaning in content was less complex, more transparent, and did not normally need unpacking, it was coded as having lower semantic density (SD-) (Maton 2019, 64–65).

Slides that included one mode only (e.g. only text – see Figure 2) were coded as one item of content. Slides that combined a range of modes (e.g. text, video, and graphics – refer to Figure 3) were coded individually, each mode representing a separate item (e.g. text = i1, video content = i2, graphic 1 = i3, graphic 2 = i4, etc.) and coded in the same order as presented by the lecturer. In the case of Figure 2, the item was coded as rhizomatic (SG-/SD+) as meaning was abstract and highly condensed and removed from any specific context of use or application (i.e. students would need some previous disciplinary-related knowledge to understand the processes exemplified). In Figure 3, however, both items (i.e. the text = i1; the image = i2) were coded as prosaic (SG+/SD-) as they displayed meanings that were less condensed, more 'everyday' and grounded in a specific context or concrete reality (i.e. there is less to unpack and most students would be able to grasp the ideas and concepts developed in the text and graphic regardless of whether they are familiar with Joyce's work or not).

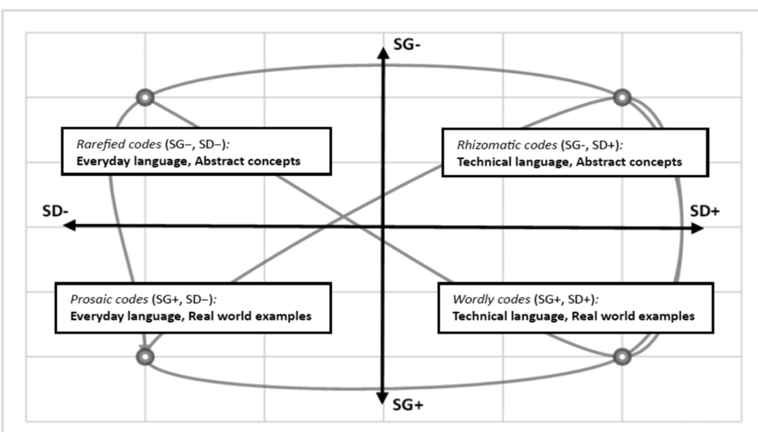


**Figure 1.** Semantic plane and codes (Maton 2016, 16).

**LESSON 3: Bonding in Elements and Compounds** 1

**LESSON 3. Bonding in elements and compounds.** Bonding description in molecules using valence bond (VB) theory. Lewis structures. VSEPR model. Resonance in VB bonding: major canonical forms. Bonding descriptions in molecules using molecular orbital (MO) theory. Qualitative and semi-empirical MO diagrams. Electronic configuration in molecules. Diatomic molecules. $F_2$, $O_2$, $N_2$, HCl, CO and related molecules. Polyatomic molecules: $H_2O$, $NH_3$, $SO_2$, $CO_2$, $SO_3$ and related molecules. Electron deficient multi-centred bonds: $B_2H_6$. Electronegativity. Mulliken-Jaffé scale. Bonding in non-molecular solids. Band theory. Metallic bonding. Bonding in covalent solids. Conductors, semiconductors and insulators. Bonding in ionic solids. Lattice energy. Partial covalent character. Fajan´s rules. Valence and oxidation state. Structure and bonding of chemical elements.

**Figure 2.** Slides with one mode (i1).

**James Joyce**

Irish novelist, poet, playwright. Interest in the psychological, characters' inner worlds, thoughts and desires. WORKS: *Dubliners* (1914), *A Portrait of the Artist as a Young Man* (1916), *Ulysses* (1920).

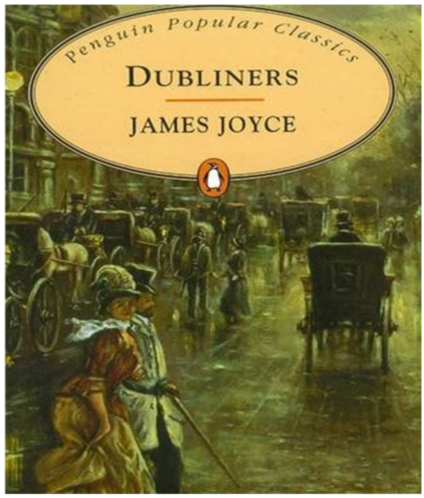


**Figure 3.** Slides with multiple modes (i2 = text and i3 = image).

### *3.3. Procedure*

Lecturers were asked to complete the DigCompEdu self-assessment questionnaire online during the length of the study. The survey was conducted in accordance with institutional review board privacy, security, and informed consent parameters that included a note that the results would be anonymised. Once permission was obtained from lecturers and their students to record their classes, we observed and recorded a total of 72 lecturers (EMI = 37; L1 = 35) from four disciplines: Arts & Humanities, Sciences, Social & Legal Sciences, and Architecture & Engineering. PowerPoint slide content used in the lectures recorded was coded by the first author of this study according to Maton's (2019) semantic plane and codes (Figure 1). Lecturers were attributed a semantic code range score of between 1 and 4 based on the entire duration of each participant's recordings. Lecturers who reported one type of semantic code throughout their recordings (e.g. only prosaic codes) attained a semantic code range of 1; those who employed two codes (e.g. only prosaic and rarefied codes) obtained a semantic code range of 2; and those who employed either three (e.g. only prosaic, rarefied and rhizomatic codes) or four codes (a full range of prosaic, rarefied, worldly and rhizomatic codes) were attributed a semantic code range of 3 or 4, respectively. To confirm accuracy, the first author of this study reviewed the data coded again after a period of two weeks. Non-parametric correlational, rank-based, and statistical hypothesis tests were used. Given that even sizable differences may test as non-significant in small samples, as is the case in this study ($n = 20$), when certain trends were detected observing the sample, these are also outlined to follow. Quantitative analyses were conducted on all survey data collected and slide content items coded (1,680 in total) using base R (R Core Development Team, version 4.1.3. 2022).

As in previous studies (e.g. Argüelles-Álvarez and Morton 2023; Curzon et al. 2020), semantic profiling was applied to further explore semantic codes and waves from a qualitative perspective. To reveal shifts between the forms of knowledge being expressed and levels of complexity and context-dependence in PowerPoint items we did the following. We began by further scrutinizing the range of semantic codes used by lecturers, after which items coded were plotted accordingly to generate semantic profiles for each lecturer based on the entire duration of their recordings. Table 2 provides a detailed breakdown of EMI/L1 lectures recorded and items coded based on discipline.

First, item codes were plotted on Maton's (2019) semantic plane (refer to Figure 1 in Section 3.2) to examine the range of semantic codes noted in lecturers' slide content. Next, items coded were plotted to generate an associated semantic profile for each lecturer to show changes in the condensation of meaning and context-dependence of knowledge being expressed in their PowerPoint presentations, with different shapes of semantic profiles suggesting different learning experiences. As can be seen in Figure 4, this was depicted by plotting the strengths of SG and SD on the y-axis and tracing items coded in presentations and time passing on the x-axis. Harder to understand items that evidenced **rhizomatic** codes were traced as 1 on the semantic profile scale; easier to understand items coded as **prosaic** were plotted as −1 on the semantic profile scale. In between, **rarefied** codes were attributed a value of 0.5 and **worldly** codes equated to −0.5 on the semantic profile scale.

## 4. Results

In this section, results are presented by focusing on each research question. Quantitative findings are outlined first and then immediately followed by their corresponding qualitative analysis.

### *4.1. RQ1. What is the impact of perceived ICT skills on the range of semantic codes developed in PowerPoint presentations?*

Overall, quantitative results showed that lecturers perceived their level of ICT skills as intermediate at B1 Integrator level ($M = 88.30$, $SD = 23.59$), which was corroborated in the

Table 2. Total lectures recorded and items coded.

| Discipline | Total lectures recorded | | Total items coded | |
|---|---|---|---|---|
| | L1 | EMI | L1 | EMI |
| Arts & Humanities | 4 | 8 | 64 | 73 |
| Sciences | 4 | 9 | 46 | 153 |
| Social & Legal Sciences | 16 | 14 | 470 | 226 |
| Architecture & Engineering | 11 | 6 | 477 | 171 |
| | **35** | **37** | **1,057** | **623** |
| **Total** | **72** | | **1,680** | |

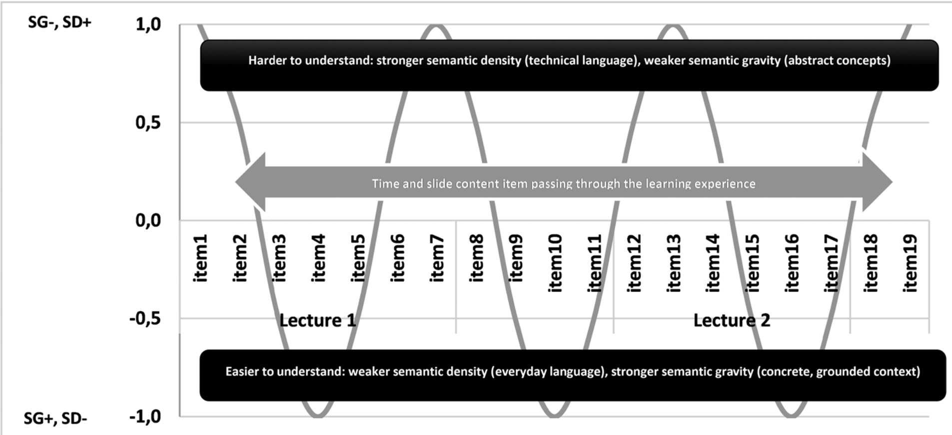


**Figure 4.** Semantic profile showing semantic waves.

areas of A6 Facilitating Learners' Digital Competence ($M = 16.85$, $SD = 6.32$), A3 Teaching and Learning ($M = 13.70$, $SD = 4.73$), A4 Assessment ($M = 10.35$, $SD = 3.39$), and A5 Empowering Learners ($M = 9.75$, $SD = 3.49$). A higher level of competence was noted in the areas of A1 Professional Engagement ($M = 16.45$, $SD = 3.35$) and A2 Digital Resources ($M = 13.35$, $SD = 3.39$) at Expert B2 level; while less confidence was observed in relation to dimension A7 Open Education ($M = 7.85$, $SD = 3.90$), perceived at A2 Explorer level.

When asked how often they used ICT tools in their teaching, the majority (80%) said more than 75% of the time, with only 5% reporting between 11% and 25% usage. Participants used mostly presentations (100%), videos and audios (95%) in their teaching and learning, while 45% created their own video or audio content. Nearly all teachers (85%) agreed they felt at ease using ICT tools for personal matters, using the Internet in Spanish (100%) and English (95%), and showed a clear interest in using new technologies (80%), which did not extend to social media (40%). Lastly, lecturers were asked to consider the university's degree of implication in relation to ICT competence, which again was mostly positive. Teachers felt that the institution: provided a fast and reliable Internet connection (85%), suitable accessibility for students to use digital tools (85%), and the necessary technical support (60%); fostered the development of ICT skills (60%) and the integration of ICT technologies in teaching (60%); and invested in updating and improving the technical infrastructure (60%).

Spearman's rank correlation reported a positive correlation between perceived ICT skills and overall semantic codes in slide content, $r$ (18) = 0.12, $p = 0.612$, albeit not significant. Upon further scrutiny, this positive correlation did not extend to all areas of ICT skills and was most strongly linked to Facilitating Learners' Digital Competence (DigCompEdu Area 6), $r$ (18) = 0.40, $p = 0.079$ (Table 3).

Qualitative analyses of individual semantic profiles and multimodality in slide content partially supported the positive quantitative correlation between the overall range of semantic codes observed in lecturers' slide content and their perceived ability to facilitate learners' digital competence (DigCompEdu Area 6 – see Appendix). As can be seen in Table 4, lecturers (all from the Social & Legal Sciences and highlighted in the table) who reported B2 Expert level or above in DigCompEdu Area 6 (i.e. a score of 20 or above) developed all four semantic codes. Although most of these three lecturers' slide content was coded in

Table 3. Spearman's rank correlation between perceived ICT skills and semantic codes.

| Variables | Coef correlation | *p*-value |
|---|---|---|
| Total perceived ICT skills – semantic codes | 0.12 | 0.612 |
| A1 Professional Engagement – semantic codes | −0.01 | 0.978 |
| A2 Digital Resources – semantic codes | −0.06 | 0.815 |
| A3 Teaching and Learning – semantic codes | −0.02 | 0.920 |
| A4 Assessment – semantic codes | −0.10 | 0.680 |
| A5 Empowering Learners – semantic codes | 0.17 | 0.478 |
| **A6 Facilitating Learners' Digital Competence – semantic codes** | **0.40** | **0.079** |
| A7 Open Education – semantic codes | 0.08 | 0.755 |

the harder to understand rhizomatic (SG-/SD+) range (50% to 67%), their PowerPoint presentations also included easier to understand codes: prosaic (SG+/SD- 3.7% to 15%); worldly (SG+/SD+ 7% to 37%); and rarefied (SG-/SD- 3.7% to 19%). In addition, these lecturers evidenced semantic waves (between 1 and 9) and used a variety of modes (between 4 and 6) in their content. Upon further scrutiny, however, only EMI Social & Legal Sciences Year 1 lectures showed this positive correlation to be linked to more semantic waves. The modes used in these lectures comprised text, graphics, websites, and academic journals, with most slides (85%) combining text with graphics in line with other presentations (refer to Table 5 in section 4.2).

### 4.2. RQ2. How are semantic codes and waves developed in PowerPoint presentations across disciplines and in different languages of instruction?

In terms of academic discipline and language of instruction from a quantitative perspective, a Kruskal-Wallis Test showed that lecturers' academic discipline significantly affected the overall range of semantic codes in slide content (Gp1, n = 12: Arts & Humanities/Social & Legal Sciences, Gp2, n = 3: Sciences, Gp3, n = 5: Architecture & Engineering), $\chi^2(2, n = 20) = 12.831$, $p = 0.002$). Arts & Humanities/Social & Legal Sciences lecturers recorded a higher median score ($Md = 4.00$) than lecturers from other disciplines (Sciences, Architecture & Engineering $Md = 2.00$). Post-hoc Dunn tests revealed the differences between Arts & Humanities/Social & Legal Sciences and Sciences/Architecture & Engineering to be significant ($p = 0.012$). In contrast, a Wilcoxon Signed Rank Test revealed language of instruction not to be statistically significant ($p = 0.74$), with EMI ($M = 3.30$, $SD = 1.16$) and L1 lecturers ($M = 3.22$, $SD = 1.09$) reporting similar trends in terms of semantic codes used in slide content.

In line with quantitative findings, semantic profiles confirmed disciplinary differences when scrutinised qualitatively (see Table 4). Although the majority of slide content conveyed harder to understand rhizomatic codes, this was far more predominant in the hard sciences. For L1 lecturers in the Sciences and Architecture & Engineering it was over 90% (under 83% in the soft sciences), while for EMI lecturers it was over 63% (under 56% in the soft sciences). In addition, lectures in the Sciences did not include easier to understand prosaic codes, with slide content embedding the lowest number of modes in their presentations: 62%-98% text and graphics; 2%-38% text only (see Table 4).

Overall, presentations in the hard sciences reported less semantic waves than those in the soft sciences. Science and Architecture & Engineering presentations developed mainly high flatlining profiles (i.e. rhizomatic codes SG-/SD+, within the harder to understand range of the semantic profile scale), with unpacking and repacking of abstract language and

**Table 4.** Range of semantic codes in relation to DigCompEdu area 6.

| | DigCompEdu area 6 | Prosaic % | Worldly % | Rarefied % | Rhizomatic % | SW | Modes |
|---|---|---|---|---|---|---|---|
| **L1** | | | | | | | |
| Arts & Humanities (Y2) | 10 | 28 | 33 | 6 | 33 | 3 | 5 |
| Arts & Humanities (Y3) | 15 | 4.35 | 30.43 | 23.91 | 41.3 | 2 | 8 |
| Social & Legal Sciences (Y1) | 17 | 5 | 27 | 19 | 49 | 1 | 7 |
| Social & Legal Sciences (Y3) | 16 | 48.5 | 17.8 | 14.4 | 19.3 | 20 | 4 |
| Social & Legal Sciences (Y3) | 17 | 9 | 32 | 23 | 36 | 4 | 5 |
| Social & Legal Sciences (Y3) | 15 | 0 | 15 | 2 | 83 | 0 | 3 |
| **Social & Legal Sciences (Y4)** | **33** | **7** | **7** | **19** | **67** | **3** | **6** |
| Sciences (Y1) | 18 | 0 | 7 | 0 | 93 | 0 | 2 |
| Architecture & Engineering (Y3) | 16 | 0 | 0 | 0 | 100 | 0 | 4 |
| Architecture & Engineering (Y3) | 13 | 0 | 1 | 0 | 99 | 0 | 3 |
| Architecture & Engineering (Y4) | 18 | 0.7 | 7.5 | 1.5 | 90.3 | 1 | 6 |
| **EMI** | | | | | | | |
| Arts & Humanities (Y2) | 15 | 3 | 8 | 38 | 51 | 0 | 5 |
| Arts & Humanities (Y4) | 11 | 3 | 3 | 41 | 53 | 1 | 4 |
| **Social & Legal Sciences (Y1)** | **30** | **15** | **24** | **11** | **50** | **9** | **4** |
| **Social & Legal Sciences (Y3)** | **27** | **3.7** | **37** | **3.7** | **55.6** | **1** | **5** |
| Social & Legal Sciences (Y3) | 17 | 24 | 18 | 24 | 34 | 6 | 6 |
| Sciences (Y1) | 13 | 0 | 2.7 | 18.8 | 78.6 | 0 | 2 |
| Sciences (Y2) | 8 | 0 | 0 | 0 | 100 | 0 | 2 |
| Architecture & Engineering (Y3) | 13 | 0 | 1 | 0 | 99 | 0 | 3 |
| Architecture & Engineering (Y3) | 15 | 5.4 | 0 | 31.1 | 63.5 | 3 | 4 |

*Y1, Y2, Y3 and Y4 (in brackets) = year of study of the module within the undergraduate degree programme
** DigCompEdu TDC Area 6 = 'Facilitating Learners' Digital Competence' (refer to Appendix).

technical concepts rarely connecting abstract ideas to concrete examples and/or breaking down complex knowledge into component ideas, expressed in everyday language. For example, when explaining Symmetry Elements and Operations in Inorganic Chemistry, new concepts and theories were introduced that linked back to previously learnt things, either in the curriculum or in mechanistic explanation using three or more chemistry-specific terms (Figure 5).

In contrast, the majority of Arts & Humanities and Social & Legal Sciences presentations evidenced semantic waves, ranging from the harder to understand (i.e. rhizomatic codes, SG-/SD+) to the easier to understand (i.e. prosaic codes SG+/SD-) scales of the semantic profile, corroborating unpacking and repacking of more abstract and technical knowledge being linked to concrete, simpler knowledge. For instance, in the Social & Legal Sciences, when the Orff method was presented to students for the first time, a video with a concrete example of this method in a general context was shown subsequently.

**Table 5.** Most frequent range of modes used in PowerPoint presentations.

| | Text % | Graphics % | Website % | Text + graphics % | Text + website % | Video + website % | Text + graphics + website/ video % | Text + graphics + ac lit/ online media/LMS % |
|---|---|---|---|---|---|---|---|---|
| Most frequently used modes | 13 | 6 | 0,4 | 58 | 2 | 7 | 1 | 6 |
| **L1** | | | | | | | | |
| Arts & Humanities (Y2) | | 11 | | | 33 | 50 | | |
| Arts & Humanities (Y3) | | | | 15 | | 43 | 9 | |
| Social & Legal Sciences (Y1) | 14 | | | 24 | | | | 22 |
| Social & Legal Sciences (Y3) | | 39 | | 58 | | | 2 | |
| Social & Legal Sciences (Y3) | 52 | | | 7 | | 18 | | |
| Social & Legal Sciences (Y3) | 2 | | | 98 | | | | |
| Social & Legal Sciences (Y4) | | | | 79 | | | 7 | 10 |
| Sciences (Y1) | 9 | | | 91 | | | | |
| Architecture & Engineering (Y3) | 16 | | | 81 | | | 1 | |
| Architecture & Engineering (Y3) | 13 | 18 | | 63 | | | | |
| Architecture & Engineering (Y4) | | | 1 | 96 | | | 2 | |
| **EMI** | | | | | | | | |
| Arts & Humanities (Y2) | 13 | | | 33 | | | | 41 |
| Arts & Humanities (Y4) | | 3 | | 62 | | | | 29 |
| Social & Legal Sciences (Y1) | 7 | | | 85 | | | | 3 |
| Social & Legal Sciences (Y3) | 11 | | | 65 | | 7 | | |
| Social & Legal Sciences (Y3) | 39 | 13 | | | | 21 | | |
| Sciences (Y1) | 37 | 1 | | 62 | | | | |
| Sciences (Y2) | 2 | | | 98 | | | | |
| Architecture & Engineering (Y3) | 22 | 14 | | 60 | | | | |
| Architecture & Engineering (Y3) | 5 | | | 81 | | | | 5 |

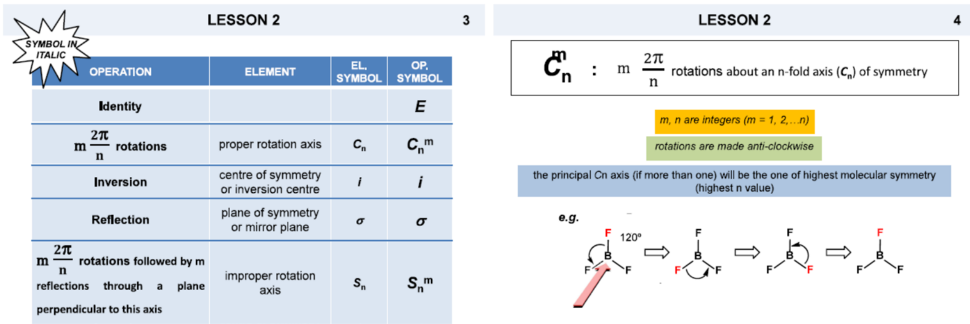


**Figure 5.** Symmetry elements and operations in inorganic chemistry.

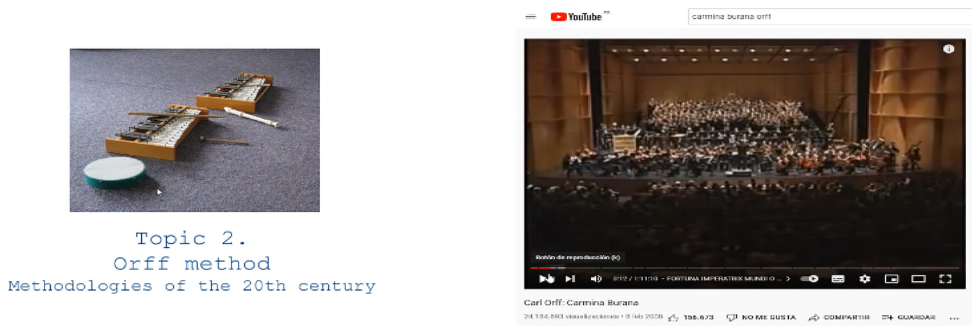


**Figure 6.** The Orff method.

Although the term introduced at first was subject-specific, no advanced, subject-specific terminology or concepts were required to understand the explanation in the video (Figure 6).

Upon further scrutiny, however, when the same subjects in the soft sciences were compared based on the language of instruction used, only L1 lecturers in the Arts & Humanities appeared to build knowledge cumulatively in their presentations throughout lectures. These lecturers were the only to register semantic waves in their slide content across every lecture recorded (Figure 7). Interestingly, these teachers combined video and websites on their slides to a greater extent (over 43%) than other lecturers. In contrast, EMI lecturers only generated waves in one lecture (i.e. 25% of the time – Figure 7) and combined mostly text and graphics on their slides (over 62%).

## 5. Discussion

To examine knowledge-building practices in PowerPoint presentations, quantitative and qualitative data were analysed to understand how multimodal slide content moves between concrete, simpler knowledge and more abstract, complex knowledge in undergraduate lectures. Three interesting patterns emerged in relation to meaning-making practices in undergraduate slide content: (1) the notable impact of disciplinary differences; (2) the ability of English language proficiency to eclipse disciplinary variance; and (3) the relevance of multimodal competence in EMI teacher development.

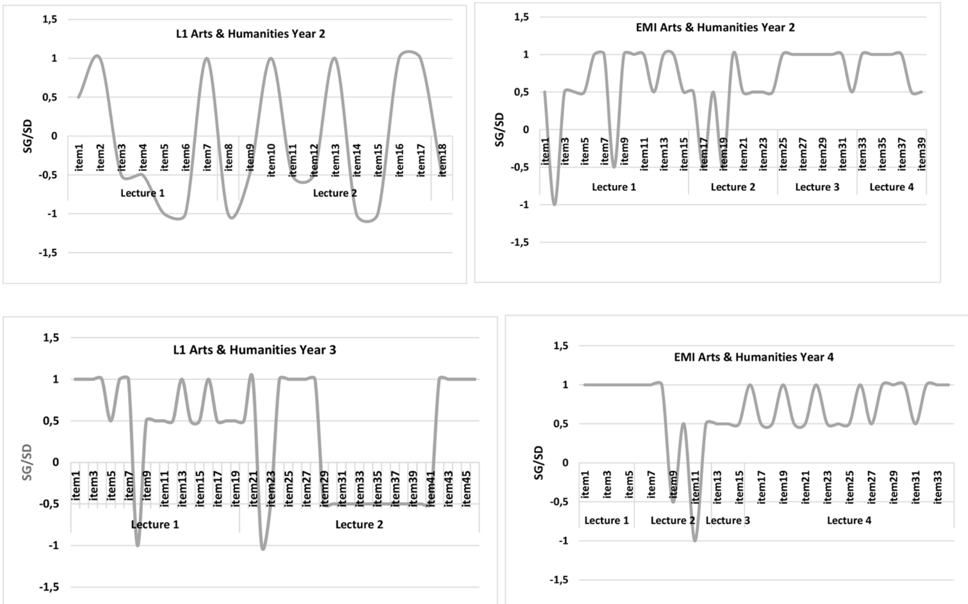


**Figure 7.** Arts & Humanities semantic profiles depending on language of instruction used.

In contrast to previous findings (e.g. Amua-Sekyi and Asare 2016; Santos et al. 2022), we could not establish a clear relationship between perceived ICT skills and semantic codes in PowerPoint presentations (RQ1). Although lecturers who self-reported a greater ability to facilitate learners' digital competence (DigCompEdu Area 6) attested a greater spectrum of semantic codes, this only equated to more semantic waves in one case when examined qualitatively. In addition, modes in slide content were very similar across the board. This leads us to infer that other factors may determine semantic waves more than ICT skills. The fact that the majority of lecturers (92%) in the soft sciences developed a full range of semantic codes in their presentations, in comparison to those in the hard sciences (13%), could suggest that disciplinarity may determine semantic codes more than ICT skills. Furthermore, this association is noteworthy as it underscores the need for further research to examine the link between how knowledge is constructed in lecturers' presentations and lecturers' ability to foster their students' digital competence. The analysis of students' productions in terms of how they apply ICT skills to construct meaning related to slide content and semantic waving developed in lectures could shed further light on this issue.

Subsequent analyses confirmed academic discipline had a clear impact on knowledge--building practices in PowerPoint presentations (RQ2). In line with studies by Clarence (2016b), Cranwell and Whiteside (2020), and Mouton (2020), subjects in the soft sciences included a greater range of semantic codes by twofold and evidenced more semantic waves in comparison to those from the hard sciences. This further endorses scholars' (e.g. Airey 2020; Bolton and Kuteeva 2012; Morell et al. 2020) claim that disciplines have their own specialist discourses that students need to master, and for this reason knowledge construction in the EMI classroom needs to be examined from a disciplinary perspective.

Upon further scrutiny, a more nuanced glanced at lecturers' semantic profiles revealed a deviant trend based on language of instruction. Qualitative results showed knowledge--building practices to be more dynamic in L1-taught lectures in the Arts & Humanities, which does not support Velilla-Sánchez's (2021) claim that many more resources in communication and meaning construction are exploited in the EMI classroom. What it may imply is that insufficient language skills appear to hamper the successful implementation of semantic waves to a greater extent than disciplinary differences. As claimed by participants in a study by Doiz et al. (2013), language proficiency may have a significant impact on the success of students in multilingual educational contexts where a majority L1 language and a foreign language (English) are in contact. What is more, the fact that the language of instruction had a less noticeable effect in the hard sciences may indicate that language proficiency has a weaker impact on subjects and disciplines that remain in the high semantic flatline range of semantic codes that are more difficult to understand, mainly presenting technical language and abstract concepts (SG-, SD+). In other words, the more lecturers unpack and repack knowledge in slide content, moving into everyday language and real-world examples (SG+, SD-) terrain, the more language proficiency is required to maintain effective digital information literacy strategies and practices in multilingual contexts.

Consistent with the literature on multimodality (e.g. Bernad-Mechó and Fortanet-Gómez 2017; Morell et al. 2020; Querol-Julián 2023), the combination of modes served to foster cumulative knowledge construction through semantic waves in multimodal PowerPoint presentations. The fact that video content was developed to a greater extent in slide content that generated more waves supports two previous claims: 1) that effective pedagogy encompasses multimodal competence (Morell 2018); and 2) that modes that progressively display sequential images might be conducive to better academic understanding (Baker et al. 2018). Analogously, limiting PowerPoint slides to the combination of text and graphics may constrain scaffolding strategies in the process of meaning-making. Thus, it would appear that our findings continue to reinforce the design of EMI teacher training courses that include the development of multimodal competence (Morell 2018).

## 6. Conclusion

To advance the fields of semantic waves and multimodal research into PowerPoint presentations, this study presents a new interdisciplinary vision of knowledge-building practices in multilingual Spanish higher education. Quantitative and qualitative findings confirm two main findings. First, cumulative knowledge building practices through semantic waves seem to be developed to a greater extent in the soft sciences, particularly in L1 Arts & Humanities PowerPoint content, but to a lesser extent in the hard sciences. Second, including video content appears to support cumulative learning through semantic waves, while limiting slide content to the combination of text and graphics may constrain scaffolding strategies in the process of meaning-making.

As to the main implications of this study for education research, the following conclusions can be drawn. Although educators' perceived level of ICT competence does not appear to be linked to their ability to unpack and repack academic content in PowerPoint presentations, the way slide content is presented to support students' understanding of theoretical and conceptual knowledge does seem to be influenced by discipline and multimodality, which, in turn, presents two challenges. To enable students to build on previous understandings and transfer what they learn into future contexts, subjects in the hard sciences with a propensity to construct knowledge in a more high semantic flatline manner need to support learners to move between concrete, simpler knowledge and more abstract, complex knowledge in multimodal presentations. Second, although slide content in the soft sciences may exhibit more semantic waves and strategies for unpacking and repacking knowledge, these can be hampered by insufficient language skills, namely when breaking down knowledge into simpler explanations and concrete examples. For this reason, it is essential that future knowledge-building practices in higher education contexts consider these outcomes in relation to both the macrocontext of education policy and the micro-context of L1 and EMI pedagogical practice initiatives. At a time when the use of technology is clearly on the increase in university lectures (González-Mujico and Lasagabaster 2019), professional development courses should focus on PowerPoint use by paying particular attention to the impact that the disciplinary culture may have on the unpacking and repacking of knowledge in addition to how modes are combined in this process. In this vein, our results seem to confirm the proposal made by Ruiz-Madrid and Fortanet-Gómez (2022, 278), who claim that there is a 'need to provide courses that address specific academic and disciplinary discourse for homogeneous groups of learners'. As Lasagabaster (2022) points out, the number of professional development courses for EMI lecturers at university level is rather scant and what is more, they tend to be aimed at EMI practitioners in general, without considering that some parts or units of such courses should be particularly addressed to lecturers stemming from the same discipline.

As to the limitations of the study, it is essential to interpret the results bearing in mind the small sample size. Significant trends highlighted could be demonstrated by increasing the sample in future studies. In addition, the strengths of SG and SD were used as analytical tools together and have not been analysed separately in this study. Future avenues of research should consider how these two constructs evolve as parallel or individual dimensions (and not combined) and their impact on student learning. In doing so, a more nuanced and holistic understanding of cumulative knowledge building practices in L1 and EMI multimodal PowerPoint presentations could be attained.

## Acknowledgements

The authors would like to acknowledge the invaluable collaboration and support received from all the participants in the study and from the Department of Statistics at the University of Oviedo who statistically validated the data collected.

## Availability of data and material

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

## Disclosure statement

The authors report there are no competing interests to declare.

## Funding

This study was financed by the European Union-Next Generation EU Margarita Salas grant and is part of the project PID2020-117882GB-I00 financed by the Spanish Ministry of Science, Innovation and Universities - MICIU/AEI/10.13039/501100011033.

## ORCID

Flor de Lis González-Mujico http://orcid.org/0000-0001-9027-3798
David Lasagabaster http://orcid.org/0000-0001-7750-2314

## References

Alkash K, Al-Dersi Z. 2013. Advantage of using Power Point presentations in EFL classroom. Int J Engl Lang Transl Stud. 1:3–16.

Airey J. 2020. The content lecturer and English-medium instruction (EMI): epilogue to the special issue on EMI in higher education. Int J Biling Educ Bilingual. 23(3):340–346. https://doi.org/10.1080/13670050.2020.1732290.

Amua-Sekyi ET, Asare PY. 2016. A survey of information communication technology literacy among lecturers. Information Knowl Manage. 6(8):1–7.

Argüelles-Álvarez I, Morton T. 2023. Using the semantics dimension of legitimation code theory to investigate lecturers' knowledge-building practices in two English-medium university computing courses. J English Acad Purposes. 65:101285. https://doi.org/10.1016/j.jeap.2023.101285.

Baker JP, Goodboy AK, Bowman ND, Wright AA. 2018. Does teaching with PowerPoint increase students' learning? A meta-analysis. Comput Educ. 126:376–387. https://doi.org/10.1016/j.compedu.2018.08.003.

Becher T. 1989. Academic tribes and territories: intellectual enquiry and the cultures of disciplines. Buckingham, UK: The Society for Research into Higher Education & Open University Press.

Bernad-Mechó E, Fortanet-Gómez I. 2017. Semiotic modes in the organization of lectures in English and in Spanish. EPiC Ser Lang Linguist. 2:224–234.

Bernstein B. 2000. Pedagogy, symbolic control, and identity: theory, research, critique (2nd ed.). New York: Rowman & Littlefield.

Bezemer J, Jewitt C. 2018. Multimodality: a guide for linguists. In Research methods in linguistics (2nd ed.), ed. L. Litosseliti. New York: Bloomsbury, p. 281–304.

Bolton K, Kuteeva M. 2012. English as an academic language at a Swedish university: parallel language use and the 'threat' of English. J Multiling Multicult Dev. 33(5):429–447. https://doi.org/10.1080/01434632.2012.670241.

Bozbıyik M, Morton T. 2023a. Lecturers' use of examples in online university English-medium instruction: a micro-analytic classroom interaction and knowledge-building perspective. Lang Educ. 1–20. https://doi.org/10.1080/09500782.2023.2173528.

Bozbiyik M, Morton T. 2023b. Transitioning between 'outside' and 'inside' knowledge in an online university EMI chemistry course. Appl Linguist. 44(2):265–286. https://doi.org/10.1093/applin/amac068.

Cabero-Almenara J, Guillén-Gámez FD, Ruiz-Palmero J, Palacios-Rodríguez A. 2021. Digital competence of higher education professor according to DigCompEdu. Statistical research methods with ANOVA between fields of knowledge in different age ranges. Educ Inf Technol (Dordr). 26(4):4691–4708. https://doi.org/10.1007/s10639-021-10476-5.

Clarence S. 2016a. Exploring the nature of disciplinary teaching and learning using legitimation code theory semantics. Teach Higher Educ. 21(2):123–137. https://doi.org/10.1080/13562517.2015.1115972.

Clarence S. 2016b. Surfing the waves of learning: enacting a semantics analysis of teaching in a first-year law course. Higher Educ Res Dev. 36(5):920–933. https://doi.org/10.1080/07294360.2016.1263831.

Cosgun Ögeyik M. 2017. The effectiveness of PowerPoint presentation and conventional lecture on pedagogical content knowledge attainment. Innov Educ Teach Int. 54(5):503–510. https://doi.org/10.1080/14703297.2016.1250663.

Cranwell PB, Whiteside KL. 2020. Investigation into the semantic density and semantic gravity wave profile of teachers when discussing electrophilic aromatic substitution ($s_e$ar). J Chem Educ. 97(10):3540–3550. https://doi.org/10.1021/acs.jchemed.0c00571.

Curzon P, Waite J, Maton K, Donohue J. 2020. *Using semantic waves to analyse the effectiveness of unplugged computing activities*. Proceedings of the 15th Workshop on Primary and Secondary Computing Education (pp. 1–10). https://doi.org/10.1145/3421590.3421606.

Dandekar PD, Dandekar DR, Parlewar C. 2017. Use of Power point presentation for teaching--perception of undergraduate Ayurveda Students. Joinsysmed. 5(2):81–85.

Doiz A, Lasagabaster D, Sierra J. 2013. Globalisation, internationalisation, multilingualism and linguistic strains in higher education. Stud High Educ. 38(9):1407–1421. https://doi.org/10.1080/03075079.2011.642349.

Fortanet-Gómez I, Crawford Camiciottoli B. 2015. Introduction. In Multimodal analysis in academic settings: from research to teaching, eds. B. Crawford Camiciottoli & I. Fortanet-Gómez. New York: Routledge, p. 1–14.

Ghomi M, Redecker C. 2019. Digital competence of educators (DigCompEdu): Development and evaluation of a self-assessment instrument for teachers' digital competence. CSEDU. 1:541–548.

González-Mujico F, Lasagabaster D. 2019. Enhancing L2 motivation and English proficiency through technology. Complu J Eng Stud. 27: 59–78. https://dx.doi.org/10.5209/cjes.62990.

Hallewell MJ, Lackovic N. 2017. Do pictures 'tell' a thousand words in lectures? How lecturers vocalize photographs in their presentations. Higher Educ Res Dev. 36(6):1166–1180. https://doi.org/10.1080/07294360.2017.1303454.

Johnson R, Bourdieu P. 1993. The field of cultural production: essays on art and literature. Cambridge: Polity.

Johnson DA, Christensen J. 2011. A comparison of simplified-visually rich and traditional presentation styles. Teach Psychol. 38(4):293–297. https://doi.org/10.1177/0098628311421333.

Jiang L, Zhang LJ, May S. 2016. Implementing English-medium instruction (EMI) in China: teachers' practices and perceptions, and students' learning motivation and needs. Int J Biling Educ Bilingual. 22(2):107–119. https://doi.org/10.1080/13670050.2016.1231166.

Jurado JV. 2015. A multimodal approach to persuasion in conference presentations. In Multimodal analysis in academic settings: from research to teaching, eds. B. Crawford Camiciottoli and I. Fortanet-Gómez. New York: Routledge, p. 108–130.

Kirk S. 2017. Waves of reflection: seeing knowledge(s) in academic writing. In EAP in a rapidly changing landscape: issues, challenges and solutions. Proceedings of the 2015 BALEAP Conference. Garnet Education.

Kuteeva M, Airey J. 2014. Disciplinary differences in the use of English in higher education: Reflections on recent language policy developments. High Educ. 67(5):533–549. https://doi.org/10.1007/s10734-013-9660-6.

Lasagabaster D. 2022. Teacher preparedness for English-Medium instruction. J Eng Med Inst. 1: 48–64. https://doi.org/10.1075/jemi.21011.las

Lasagabaster D, Doiz A. (Eds.). 2021. Language Use in English-Medium Instruction at University: International Perspectives on Teacher Practice. New York: Routledge.

LeFebvre L, Parsons M, Entwistle C, Boyd R, Allen M. 2022. Rethinking PowerPoint slide design for multimedialearning. J Educ Technol Syst. 50(4):503–520. https://doi.org/10.1177/00472395221077628.

León SP, García-Martínez I. 2021. Impact of the provision of PowerPoint slides on learning. Comput Educ. 173:104283. https://doi.org/10.1016/j.compedu.2021.104283.

Lewis P. 2016. Brain friendly teaching – reducing learner's cognitive load. Acad Radiol. 23(7):877–880. https://doi.org/10.1016/j.acra.2016.01.018.

Maton K. 2013. Making semantic waves: A key to cumulative knowledge-building. Linguist Educ. 24(1):8–22. https://doi.org/10.1016/j.linged.2012.11.005.

Maton K. 2014. Building powerful knowledge: The significance of semantic waves. In Knowledge and the future of the curriculum. palgrave studies in excellence and equity in global education, eds. B. Barrett, and E. Rata. London: Palgrave Macmillan. https://doi.org/10.1057/9781137429261_12.

Maton K. 2016. Legitimation code theory: building knowledge about knowledge-building. In Knowledge-building: educational studies in legitimation code theory, eds. K. Maton, S. Hood and S. Shay. London: Routledge, p. 1–23.

Maton K. 2019. Semantic waves: context, complexity and academic discourse. In Accessing academic discourse: systemic functional linguistics and legitimation code theory, eds. J. R. Martin, K. Maton, and Y. J. Doran. London: Routledge, p. 59–85. https://doi.org/10.4324/9780429280726.

Mayer R. 2014. The Cambridge handbook of multimedia learning (2nd ed.). University of California: Cambridge University Press.

Mora-Cantallops M, Inamorato dos Santos A, Villalonga-Gómez C, Lacalle Remigio JR, Camarillo Casado J, Sota Eguzábal JM, Velasco JR, Ruiz Martínez PM. 2022. Competencias Digitales del Profesorado Universitario en España. Un Estudio Basado en los Marcos Europeos DigCompEdu y OpenEdu. EUR 31127 ES, Publications Office of the European Union, Luxembourg. https://doi.org/10.2760/448078.

Morell T. 2018. Multimodal competence and effective interactive lecturing. System. 77:70–79. https://doi.org/10.1016/j.system.2017.12.006.

Morell T, Norte N, Beltran-Palanques V. 2020. How do trained EMI lecturers combine multimodal ensembles to engage students? In La Docencia en la Enseñanza Superior. Nuevas Aportaciones Desde la Investigación e Innovación Educativas, ed. R. Roig. Barcelona: Octaedro, p. 308–321. http://hdl.handle.net/10045/110076.

Mouton M. 2020. A case for project based learning to enact semantic waves: towards cumulative knowledge building. J Biol Educ. 54(4):363–380. https://doi.org/10.1080/00219266.2019.1585379.

Querol-Julián M. 2023. Multimodal interaction in English-medium instruction: How does a lecturer promote and enhance students' participation in a live online lecture? J Engl Acad Purposes. 61:101207. https://doi.org/10.1016/j.jeap.2022.101207.

Redecker C. 2017. European Framework for the Digital Competence of Educators: DigCompEdu. EUR 28775 EN, Publications Office of the European Union, Luxembourg, 2017, ISBN 978-92-79-73718-3 (print),978-92-79-73494-6 (pdf), doi:10.2760/178382 (print),10.2760/159770 (online), JRC107466.

Roberts D. 2017. The engagement agenda, multimedia learning and the use of images in higher education lecturing: or, how to end death by PowerPoint. J Further High Educ. 42(7):969–985. https://doi.org/10.1080/0309877X.2017.1332356.

Ruiz-Madrid MN, Fortanet-Gómez I. 2022. Teacher professional development for the integration of content and language in higher education. Innov Lang Learn Teach. 16(4-5):277–280. https://doi.org/10.1080/17501229.2022.2123678.

Sánchez RB, Cejudo CL, Gavira SA, Gavira RB. 2021. Autopercepción inicial y nivel de competencia digital del profesorado universitario. Texto Livre, Linguagem e Tecnologia. 15:1–24. http://hdl.handle.net/10498/26227.

Sánchez-Caballé A, Esteve-Mon FM. 2022. Digital teaching competence of university teachers: a comparative study at two European universities. AJET. 38(3):50–61. https://doi.org/10.14742/ajet.7408.

Santos C, Pedro N, Mattar J. 2022. Digital competence of higher education professors in the European context: a scoping review study. Int J Emerg Technol Learn. 17(18), 222–242.

Velilla-Sánchez MA. 2021. Bilingual resources in English-medium instruction lectures: the role lecturer's L1 is playing in EMI courses. Lang Value. 14(2):45–67. http://www.languagevalue.uji.es.

Wecker C. 2012. Slide presentations as speech suppressors: when and why learners miss oral information. Comput Educ. 59(2):260–273. https://doi.org/10.1016/j.compedu.2012.01.013.

## Appendix: DigCompEdu areas and items of ICT skills

| Competence area (dimension) | Competence items |
| --- | --- |
| 1. Professional Engagement | 1.1 Organisational communication<br>1.2 Professional collaboration<br>1.3 Reflective practice<br>1.4 Digital Continuous Professional Development (CPD) |
| 2. Digital Resources | 2.1 Selecting digital resources<br>2.2 Creating and modifying digital resources<br>2.3 Managing, protecting and sharing digital resources |
| 3. Teaching and Learning | 3.1 Teaching<br>3.2 Guidance<br>3.3 Collaborative learning<br>3.4 Self-regulated leaming |
| 4. Assessment | 4.1 Assessment strategies<br>4.2 Analysing evidence<br>4.3 Feedback and planning |
| 5. Empowering Learners | 5.1 Accessibility and inclusion<br>5.2 Differentiation and personalisation<br>5.3 Actively engaging learners |
| 6. Facilitating Learners' Digital Competence | 6.1 Information and media literacy<br>6.2 Digital communication and collaboration 6.3 Digital content creation<br>6.4 Responsible use<br>6.5 Digital problem solving |
| 7. Open Education | 7.1 Finding and using open licenses<br>7.2 Adopting open educational practices<br>7.3 Publishing in open access journals |