Investigating the use of multimodal screencasts to teach disciplinary concepts in higher education.

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Abstract

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Investigating the use of multimodal screencasts to teach disciplinary concepts in higher education (HE)

This research study explores the use of multimodal lecture screencasts to teach disciplinary concepts in an Irish higher education (HE) context.

It builds on an Inquiry Graphics (IG) framework, extending it into a multimodal inquiry framework (MMI) to examine screencasts crafted by lecturers to teach key concepts within their discipline.

Multimodality is a widely recognised and applied approach that observes communication as including language but also encompassing other modes of communication, such as sound, image, touch, gesture, feeling, etc. However, studies that provide an in-depth examination of multimodality in teaching and learning in higher education are still scarce. The proposed MMI framework provides a lens to explore graphic-pictorial, linguistic, aural, and spatial- design modes and analyse the semiotic organisation of lecturers' screencasts, to understand how multimodality relates to teaching and reveals lecturers' semiotic choices.

Qualitative IG elicitation interviews were conducted with 16 HE lecturers from a range of disciplines, where the IG framework provided an analytical opportunity to co-examine the underlying assumptions about how content is presented multimodally.

An awareness of the semiotic dimensions of each mode was uncovered, along with structures within the lecturers' sociocultural context which influenced their decision-making. The use of the MMI framework revealed the semiotic purpose of the graphic-pictorial elements primarily as unprobed representations of the chosen concept. Linguistic choices helped explain the concept within the discipline, while prosodic features of the voice, along with music, were often used intentionally by the lecturer to highlight the relative importance of the elements on screen. The enactment of software features in the screencast design indicated lecturers' embodied cognition through multimedia, along with digital fluency.

The MMI framework may be a helpful teaching tool to support HE lecturers in video and multimedia analysis to unpack the plurality of conceptual representations within multimodal digital artefacts.

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Acknowledgements

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Dedicated to the memory of my sister Jackie and my father John

Declaration

This thesis results entirely from my own work and has not been offered previously for any other degree or diploma.

Signed:

Geraldine McDermott-Dalton

Publications derived from work on the Doctoral Programme

Module 1: Research Methods in Education and Social Science Settings: Philosophy, methodology, techniques, and tools.

McDermott, G. (2020). Am I building a bubble around me? A phenomenographic study exploring students' perceptions of online personalised filters and information literacy. Paper presented at the 12th International Conference on Networked Learning. May 20th [Online]. Available at: https://www.networkedlearning.aau.dk/digitalAssets/826/826403_21.- mcdermott-dalton---am-i-building-a-bubble-around-me-a-phenomenographic-study- exploring-students--perceptions-of-online-personalised-filters-and-in.pdf

Module 2: The Development of Professional Practice. (A literature review on audio feedback was used as part of a nationally funded project on using Technology for Feedback with first year students).

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McDermott, G. (2022, November 7-9). *What lies beneath? Using a multimodal inquiry framework to examine lecturers' semiotic choices in the design and development of multimodal screencasts to teach disciplinary concepts in higher education.* Presentation at the 15th annual International Conference of Education, Research and Innovation, Seville, Spain.

McDermott, G. (forthcoming 2023, March 6-8). *Multimodal inquiry: an alternative approach to teaching disciplinary concepts in higher education.* Presentation at the 17th annual International Technology, Education and Development Conference, Valencia, Spain.

Chapter 1: Introduction

1.1. Personal Motivation for this Study

The motivation for this research study came from a desire to understand the reasons behind Higher Education (HE) lecturers' choice of specific resources, such as images, text, and narration, when creating instructional screencasts for their students. This was prompted by a critical incident (Tripp, 2011) during a postgraduate research conference, in which another PhD student presented research on measuring brain activity to provide empirical evidence of participants' reactions to certain visual stimuli. The student stressed the importance of the objectivity of the study, i.e., by measuring the brain activity, he could rule out any potential filtering of information by participants and get to the scientific, evidence-based truth.
However, I noted that the visual stimuli he presented to participants were loaded with cultural and social references. If the images were changed, the reaction of the participants could have been very different, which led me to consider the meaning-making potential of these visual stimuli. In his presentation, the doctoral student included images that were based on his experiences and culture, and the meanings he inferred from these representations based on an internal conversation (Archer, 2003) over time. Could the same be said for visual stimuli chosen by lecturers? If so, what did they see as the meaning-making potential of these stimuli in the context of the topic they were teaching?

During the residential week at Lancaster University, I was introduced to Inquiry Graphics by Dr. Natasa Lacković. As a theoretical and applied semiotic approach to communication and learning, Inquiry Graphics places visual media at the centre of knowledge inquiry in teaching or research. Since I was interested in the use of instructional screencasts which combine a number of modes, this inquiry approach could provide an insight into the decisions behind the creation of the digital artefact.

1.2. Research Gap

Multimodality has featured in a number of studies (Archer, 2014; Archer & Breuer, 2016; Bezemer & Jewitt, 2010; Kress, 2010, 2015; MODE, 2012; Smith, 2017) and is often explored in relation to learning (Bezemer et al., 2012; Cornell et al., 2022; Early et al., 2015; Kress & Selander, 2012a; Sembiante et al., 2020; Volkwyn et al., 2019). However, these are often positioned in school research, such as Jewitt (2003), who

explores the use of computer mediated resources in post-primary school English, Maths and Science or Zhao (2012, p. 3), who examines the "(re)shaping of knowledge structures in the age of digital multimedia learning" in primary school social science. In higher education, the focus on multimodality is often linked to language learning (Adams-Tukiendorf et al., 2022; Coccetta, 2018; Pinar, 2019) or communication and literacy (Gourlay, 2016; Nouri, 2018; O'Halloran et al., 2017; Tan et al., 2020). The digital screencast (hereafter the screencast) has also been the focus of numerous studies, primarily as an instructional aid (Fang & Wickersham-Fish, 2020; Kharisma, 2020; Lowenthal, 2022; Morris & Chikwa, 2014) or for giving feedback (Belt & Lowenthal, 2021; Killingback et al., 2019; Kim et al., 2017; Mahoney et al., 2019; Penn & Brown, 2022). However, there is a dearth of research which considers the multimodality and semiotic meanings of the digital screencast, in a higher education context. This thesis attempts to address that gap.

The screencast: a video lecture

The screencast was initially defined by Jon Udell in 2005 as a "digitally recorded playback of computer screen output which often contains audio narration" (Brown et al., 2009, p. 1748). Figure 1.1 below provides a visual example of one of the screencasts included in this thesis.

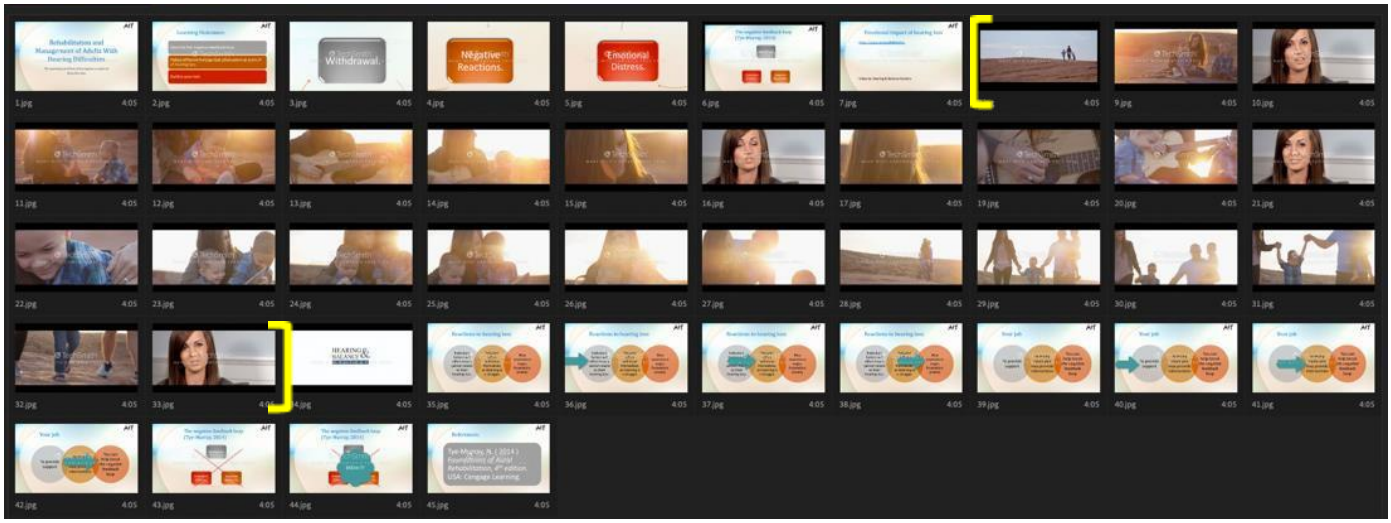


Figure 1:1: Visual composition of a screencast on The Psychological Effects of Hearing Loss

In essence, the screencast is a video recorded lecture, which may include voice over slides or screen recordings (Crook & Schofield, 2017), embedded external videos, or a combination of these features. It may also include narrator presence from a webcam either within the frame or overlapping the content (ibid), however none of the

screencasts analysed in this thesis include this feature. In the example above, PowerPoint slides are narrated, and an external video is embedded in the screencast. Figure 1.2 below shows a close up of one slide, which was created using PowerPoint and narrated by the lecturer within the screencast.

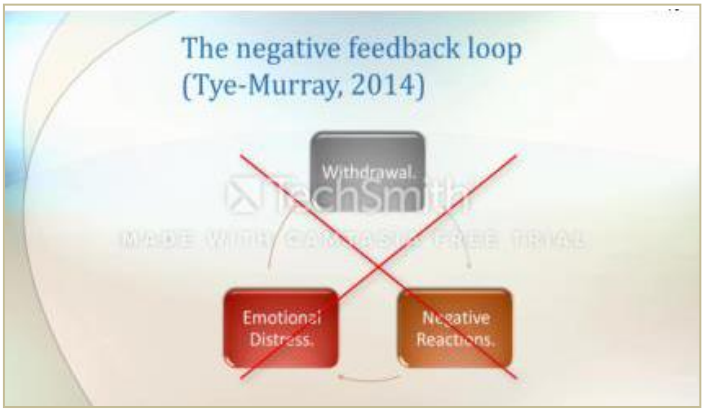


Figure 1:2: A PowerPoint slide included in the above screencast

The way in which lecturers design the screencast is central to this thesis and multimodality and Edusemiotics provide a theoretical lens through which to view this video lecture. Multimodality considers the contribution of all modes to the communicative task (Jewitt, 2013a) and encourages a move away from the logocentric traditions, which give communicative preference to speech and writing. The "multimodal ensemble" (ibid, p. 3) which is the instructional screencast combines speech, writing, images, and sound, and while specific modes may carry the main "functional load" (Jewitt, 2012b, p. 51) or how the information is distributed, unless all modes are considered, the meaning can only be partially understood. Equally, the potential for transduction (Kress, 2005), i.e., translation of meaning into another mode merits examination, since this synaesthesia (ibid) may change the intended message for the recipient. Edusemiotics stems from Peirce's semiotics and builds on the philosophical and semiotic traditions of Sebeok (2001) and Deleuze and Guattari (Semetsky, 2013) and studies signs in an educational context. Following the Peircean tradition, signs "stand to somebody for something" (Peirce, 1931-1958, 2.228, as cited in Mingers and Willcocks, 2014, p. 11). In essence, the sign is triadic and needs a mind's interpretation (interpretant) of the representamen (some sensation or representation or manifestation of a sign) and its relation to its object as the sign. A simple example might be if I see a picture of a dog, my mind interprets what I see (some graphical/visual sensation or content) as the picture showing a dog (the sign), where the real dog in the world is a direct object of the sign. If I have some

metaphorical and varied interpretations of the picture meanings, this adds further layers to the sign, expanding its object, interpretant and the sign itself. Many possible interpretations of the picture could exist, depending on the context and interpreters.

The use of Edusemiotics for this study focuses on the lecturer's semiosis (Stables & Semetsky, 2015) to explore how the signs they use within the screencast reveal their own semiotic choices. Understanding the situatedness of the sign within a historical and sociocultural context provides an insight into lecturers' interpretation of conceptual knowledge and how they represent this knowledge.

Building on the mentioned Peircean triadic model or interpretation of the sign (representamen-object-interpretant), this thesis turns to an approach that adopted the logic of Peircean triadic sign for the purpose of a critical and creative teaching and learning with visual media in higher education. This approach is Inquiry Graphics (IG) (Lacković, 2020), which refers to any graphic media (graphics) that is used analytically following Peircean semiotics for the purpose of learning any concept or area/field in higher education, especially abstract concepts.

An IG sign:

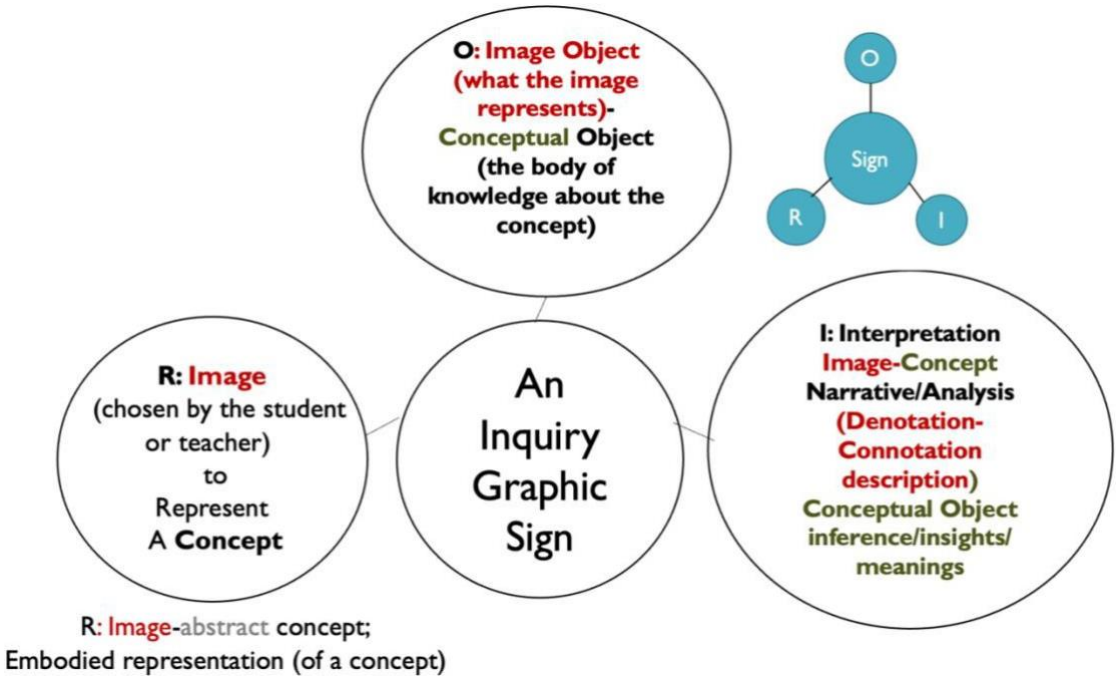


Figure 1:3: An Inquiry Graphic Sign (bringing together visual media and concepts for learning)

I use this analytical outlook in the thesis to examine the data collected and develop a MMI model which can help both teaching and analysing multimodal data.

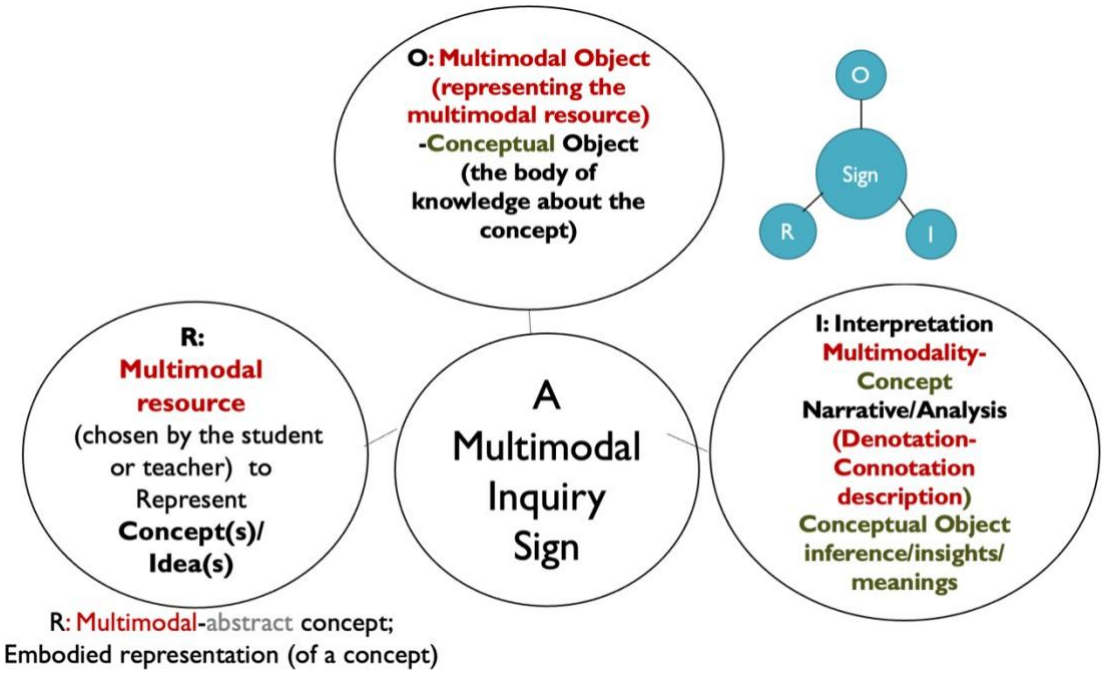


Figure 1:4: Multimodal Inquiry Sign (bringing together non-verbal multimodality and concepts for learning)

Starting with an Inquiry Graphics analysis as presented in Inquiry Graphics in Higher Education: New Approaches to Knowledge, Learning and Methods with Images (Lacković, 2020), I extend the image-abstract-concept and develop it further in a multimodal inquiry framework (Figure 3). This represents the multimodal-abstract concept as it relates to the embodied representation of a concept in higher education and provides a tool for analysis of multimodal artefacts such as the screencast.

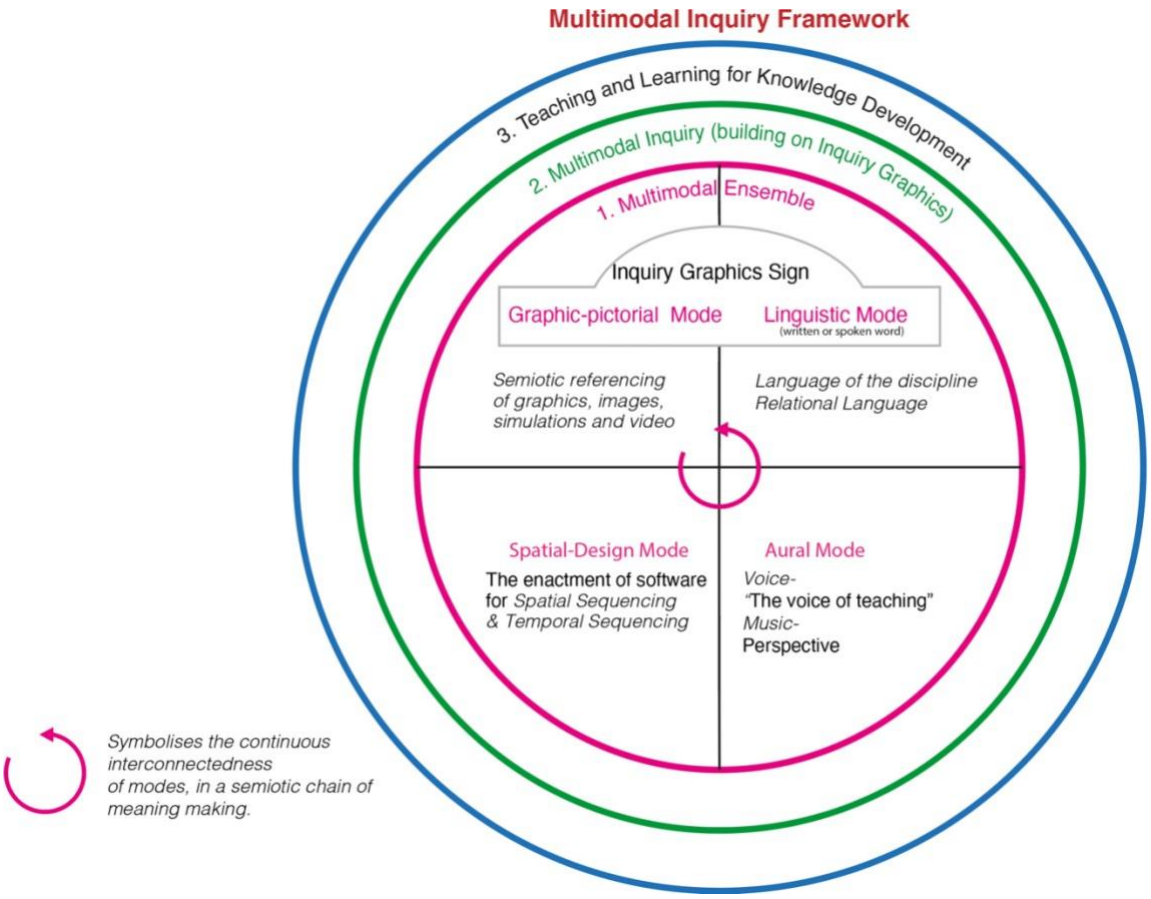


Figure 1:5: A multimodal inquiry (MMI) framework

In the literature review chapters I explore the approaches that inform the multimodal sign and the multimodal inquiry framework.

1.3. Contribution to knowledge

The multimodal inquiry framework presented above (Figure 3) is central to this thesis and is considered its main contribution. At a conceptual level it represents the multimodal-abstract concept through individual and interconnecting modes (Layer 1). However, the addition of an inquiry focus (Layer 2) distinguishes it from other similar models such as that created by the New London Group (1996), where the focus is primarily on reconceptualising literacy through multimodal communication (Unsworth, 2008), or the work of Carey Jewitt (2003), whose multimodal framework focused on multimodal communication in a school environment. Here, the purpose of the multimodal inquiry is to reveal the semiotic choices of the creator of the multimodal artefact in a Higher Education context, so that we might better understand their meaning-making practices and the intentionality of their message. This is situated in HE teaching and learning (Layer 3), where the object of inquiry is a multimodal

screencast created by lecturers to teach a concept within their discipline. In the context of lecturer professional development, examining the screencast through a multimodal inquiry lens will enable lecturer-designers to reflect on their semiotic choices and align their multimodal learning design decisions with their representation of the conceptual knowledge they wish to teach.

Chapter 3 presents the process of developing the conceptual framework, while Chapters 5 and 6 present the findings from this research which used the multimodal inquiry framework as an analytical research tool.

1.4. Focus of this research inquiry

The overall aim of this research is to examine how university educators craft digital multimodal screencasts to teach key concepts within their specific disciplines. This approach is informed by the arguments that teaching, learning and knowledge development are multimodal, as discussed in the literature review in Chapter 2. However, we still do not know enough about the relationship between the screencast as a multimodal ensemble and taught concepts in academic disciplines. The key contribution to knowledge in this thesis is a better understanding of this relationship, through a case study of one higher education university in Ireland. The research aim stated above is further divided into specific research questions:

- How can the use of a multimodal inquiry (MMI) framework, developed by the thesis researcher, that builds on an Inquiry Graphics approach, support the teaching of key disciplinary concepts? This question includes the following subquestions:
    - How are key disciplinary concepts articulated through the multimodal ensemble of the screencast?
    - How are conceptual ideas and screencast elements brought together?
- How is the multimodality of the screencast related to the sociocultural practices of the lecturer and their situated context?
- What are the implications of the findings for an understanding of online teaching and screencast-based teaching as a relationship between knowledge and its multimodal elements and affordances enacted through digital technologies– how do the two relate and what does it mean for teaching practice?

The questions above explore the multimodal instructional screencast as a digital and multimodal artefact which combines several modes, chosen by the lecturer to teach a disciplinary concept. A multimodal inquiry framework, which extends an Inquiry Graphics (Lacković, 2020) framework and builds on the Multiliteracies work of the New

London Group (1996) was developed as part of this research and is applied to the screencasts to explore how this method of inquiry could support conceptual learning.

1.5. Researcher's Positionality and the Context of the Thesis

The previous section has provided an insight into the underlying ontological and epistemological perspectives espoused in this thesis. However, Darwin Holmes (2020) suggests that positionality also includes the researcher's position within the social and political context. I come to this research from a background in teaching languages and Graphic Design technologies, alongside working as an educational technologist. As a teacher of the communicative approach in modern foreign languages, the concept of encoding and decoding (Hall, 1973) was familiar to me. The addition of digital technologies, defined by Tulinayo, Ssentume and Najjuma (2018, p.2) as technologies that "facilitate services or activities by electronic means to create, store, process, transmit and display information", included a new dimension in the communicative environment, and the affordances of these new media provided additional ways to construct the intended message. As I became more involved with Graphic Design technologies, I was introduced to visual communication and the importance of sign interpretation. However, I noted that graphic design was criticised for ocularcentrism in Graphic Design (Raff, 2013), while other disciplines were criticised for logocentrism. I concluded that to understand the message in its entirety, we should examine the use of all sensory modes and apply a multimodality approach.

Alongside teaching activities, my work as an educational technologist brought me in contact with academics in a variety of disciplines who wanted (or were encouraged) to adopt new digital technologies in their teaching. This was due in part to international and national initiatives, designed to increase digital literacy in higher education. In the UK, through its Developing Digital Literacies Programme, JISC funded a series of national projects and research to explore how digital literacies might be embedded in higher education and the resulting Digital Literacy Framework (Beetham & Sharpe, 2010) became very popular.

Newland and Handley (2016) build on this approach to develop an institutional approach to digital literacy amongst staff and provide a snapshot of the recognized and commonly agreed literacies for their institution. In the Irish context, a Roadmap for Enhancement in a Digital World 2015-2017 (National Forum for the Enhancement of Teaching and Learning in Higher Education, 2015b) included several high-level recommendations for the development of digital literacy, in particular the desire to align professional development opportunities for developing digital skills and knowledge with

pedagogy and learning design. Additionally, the Professional Development Framework for Higher Education produced in 2016 includes “personal and professional digital capacity” as one of the key domains for teachers to develop competency (National Forum for the Enhancement of Teaching and Learning in Higher Education, 2016, p. 7). Each of these reports present a high-level view of the importance of digital technologies in higher education, particularly in the context of their pedagogical value. However, no, or little attention is paid to the meaning-making affordances of digital technologies. In this thesis, I focus on digital presentation and screencasting technologies, such as PowerPoint, Camtasia and Screencastomatic and I embrace the idea that using a multimodal, semiotic approach, the affordances of these digital technologies can be highlighted (Beetham, 2013) to provide an insight into the semiotic choices of lecturers. To investigate this, I chose to recruit participants who had completed a professional development programme in Technology Enhanced Learning (TEL) and created an instructional screencast for educational purposes. This Level 9 (QQI, 2021) programme is part of the Postgraduate Diploma in Learning, Teaching and Assessment, which is offered to teachers in higher and further education in Ireland. First delivered in 2010, it introduces participants:

> “to a range of technologies for learning and [provides] them with an opportunity to try out new technologies while considering how they can make effective use of such technologies to enhance their teaching” (Athlone Institute of Technology, 2010).

Participants generally come from a range of disciplines within Science, Engineering and Business and can be either early career or experienced teaching staff. Their experiences of using digital technologies within their teaching are varied, with both early and late adopters (Straub, 2009) included. They are required to design and develop an instructional screencast related to their academic discipline and their teaching practice. The grading rubric (Appendix 1) outlines key considerations for the resource and participants also present a short rationale for the design choices they make as part of the process, referring to instructional design, universal design, or multimedia design as appropriate (these are included in the curriculum). However, little consideration is given to the multimodal nature (text, image, audio) of the screencast and the sociocultural factors which influence the lecturer’s choice of mode. Additionally, lecturers are not currently asked to consider how screencasts as a semiotic resource contribute to the development of their students’ knowledge within the discipline, which is a key part of this research.

The data gathered for this research included the instructional screencasts created by 16 lecturers[1] teaching in a HE setting. In addition, one-to-one interviews were conducted to unpack the screencast using an Inquiry Graphics analytical framework. Only participants who had successfully completed the TEL programme were included in the study, to mitigate against the potential impact of my position as co-facilitator on the programme. However, though my position as an insider researcher gave me greater insight into participants' social setting (Mercer, 2009), I must acknowledge that the position I held as programme co- facilitator may have had an influence on participant responses.

The overall findings indicate that the multimodal framework developed as part of this study is a useful tool to inquire the meaning-making practices of lecturer-designers in the creation of the multimodal screencast. By showing how multimodality is embedded in the screencast and how it extends to the domain of online and blended higher education, in particular lecturers[1]' teaching of disciplinary concepts, this thesis contributes to the field of multimodality. Additionally, it presents evidence of lecturers' commitment to moving beyond the common approach to HE teaching and learning, which is language and symbols driven, to add other modes for meaning making. Finally, it contributes to the field of technology enhanced learning, through the introduction of multimodal design in online and blended learning.

1.6. Organisation of the thesis

Following on from this introductory chapter, Chapters 2 and 3 examine literature deemed relevant to the research aim and questions. Chapter 2 initially considers how knowledge and conceptual development in higher education can be explored, while Chapter 3 subsequently moves to consider the affordances of modes and how they might contribute to conceptual knowledge development using multimodal inquiry. Finally, this chapter presents a multimodal inquiry framework (MMI), developed as part of this research study, and used to analyse the multimodal screencasts.

Chapter 4 is dedicated to presenting the characteristics of the research design adopted for this study. This chapter also includes methodological decisions, in addition to detailing the methods adopted to answer the research questions. Finally, ethical

[1] The term lecturer is used to describe all participants, regardless of whether their role includes tutoring or lecturing. This is to protect the identity of participants.

considerations are discussed together with questions of trustworthiness in qualitative research studies, such as this present study.

Chapters 5 and 6 presents the findings of the research, using the MMI framework as an analytical tool. The initial focus is on the multimodal ensemble of the screencast and presents examples from across the dataset. Following this, I provide a detailed, thick analysis of three screencasts, focusing on one of the key moments identified by the lecturer-designer and the use of an Inquiry Graphics analysis, to explore lecturers' semiotic design decisions for their multimodal screencasts.

A discussion of the findings in relation to the literature is the focus of Chapter 7, in particular how these pertain to the research aim and questions. Chapter 8 provides a summary of the research and offers some concluding remarks on the claims made in relation to the significance of this study.

Chapter 2: Developing Knowledge in Higher Education

This chapter considers key areas relevant to the design, creation, and use of the multimodal screencast to teach disciplinary concepts within a Higher Education context.

First, I explore knowledge development through the teaching of concepts across academic disciplines. I discuss knowledge building/creation as a continuous, developmental process, and move away from previous traditions of knowledge transmission within an outcomes- oriented education system. Within this space, I define concepts as fluid, multimodal representations of knowledge and consider the role of digital technologies in teaching and learning.

Second, I examine the move from a primarily monomodal tradition in higher education, which considers language as the dominant mode for knowledge communication, to a multimodal approach. Multimodal communication refers to communication realised through the inclusion and application of different modes, for example, sound and images alongside linguistic text. In contemporary higher education, digital technologies are the main enablers of this communication and engagement in teaching and learning. More recently pre-recorded video lectures or screencasts have become an integral part of online and blended higher education.

Finally, I present a multimodal inquiry framework, which builds on the work of Dr. Nataša Lacković in the domain of Inquiry Graphics, and which stems from an edusemiotic tradition. In explaining the framework which will be used to analyse the screencasts, I consider its potential for uncovering the meaning-making practices of the lecturers, influenced by their situated context, and socially situated practices.

2.1. Knowledge development across disciplines

Knowledge and conceptual development can be explored from a wide variety of perspectives. Traditionally, knowledge was presented as the product of learning, through the acquisition of either declarative or procedural information (Biggs & Tang, 2011) from authoritative sources (Scardamalia & Bereiter, 2006). This approach to knowledge acquisition was traditionally supported by a transmission-focused approach to teaching underpinned in the psychology of education, where students were considered as recipients or consumers of knowledge, which they acquired through rote-learning in many cases (Arends, 2015; Schunk, 2012; Slavin, 2012). Frameworks

were developed to help structure knowledge in an outcomes-oriented system, while concepts such as constructive alignment (Biggs & Tang, 2011) became the bedrock of a constructivist approach to teaching and learning. This concept suggests that teaching methods, goals and assessment need to be in alignment, a widely held and accepted view in higher education. However, this approach is primarily teaching and teacher-focused and strongly acquisition-oriented, ignoring learner agency and different modes of developing knowledge. It overlooks what knowledge is and how it develops in terms of communication and expression. It also disregards how learners engage and interact with this knowledge along the way, often developing and refining the knowledge base or contributing with new knowledge (Kress & Selander, 2012).

2.1.1. Knowledge as developmental

A more recent approach considers knowledge as developmental (Scardamalia & Bereiter, 2006), where knowledge building and creation emerges from interaction and engagement with existing knowledge, and learning is considered "a gradual process of coming to be" (Jewitt, 2009, p. 28). Sfard (1998) describes different metaphors of knowledge through an acquisition and participation metaphor to explain these contrasting approaches to knowledge, contending that the former focuses on "learning as gaining possession over some commodity" (p.6), which reaches an endpoint such as at the completion of an academic programme. Contrastingly, the participation metaphor moves away from this acquisition paradigm, albeit preserving goals and objectives, to consider learning as participation within a community, and acknowledges the developmental nature of knowledge (Scardamalia & Bereiter, 2006). This perspective recognizes the part each person plays in advancing the collective state of knowledge (ibid) as a public good and accepts that learners draw on their own sociocultural contexts. Learner agency is inherent in this approach, as Lave & Wenger (1991) highlight in their Community of Practice model, which espouses a participatory approach to learning and positions learners as apprentices within a community, moving from legitimate peripheral participation (LPP) to become full members through observing, listening, interacting with other members and the knowledge within this community.

Of course, other perspectives have also offered an experiential approach to knowledge development, going back to John Dewey (Andresen et al., 2017; Kolb, 2014; Miettinen, 2000) in the modern history of education. Dewey is often quoted as the initiator of the approaches to learning that highlight the experience of education, which promotes an engagement of learners' prior knowledge, inclusion of their "worlds" and

experimentation through inquiry. Inquiry learning (Bell et al., 2010; Bevevino et al., 1999; DeLuca et al., 2015) and problem-based learning (Jonassen & Hung, 2015; Savery, 2015; Savery & Duffy, 1995) are some of the developments that embraced Dewey's (and Pierce's) focus on developing knowledge and developing as a person through inquiry. Viewing knowledge and learning as developmental requires a deeper conceptual understanding and acknowledgement of the context dependent nature of knowledge and the social, cultural, and historical situatedness of the learner (Archer & Breuer, 2016). In higher education, this includes the acceptable and established customs and approaches of a community of discipline experts. The social norms and tendencies within a specific field provide lecturers and students with a way to operate within the community and these teaching and learning regimes are "local, contextually conditioned, and dynamic" (Trowler, 2019, p.107).

Historically, learning theories intended to help educators design and structure learning activities that emerged from knowledge and provide "blueprints" on how people learn. Early approaches such as behaviourism (Skinner, 1985) or constructivism (Jonassen, 1991) were accompanied by approaches such as scaffolded instruction, whose objective is the transfer of responsibility for the learning task from the teacher to the learner (Shabani et al., 2010), to increase learner autonomy and mastery. Alongside the development of these theories, new participatory approaches to learning, such as social constructivism, emerged. Vygotsky, a major proponent of social constructivism viewed learning as a social process and considered the sociocultural context important for the internalisation of knowledge within a particular community. Shawa (2020) highlights Vygotsky's use of semiotics to identify meaning making practices and connect the interpersonal with the intrapersonal to result in learning. We can argue that some of Vygotsky's concerns were of a semiotic nature and that the tradition of inquiry learning that developed from Dewey's ideas has its roots in Peirce's semiotics, who advocated strongly that meanings had to be inquired in scholarly communities and through scientific methods.

2.1.2. Situatedness of the Teacher and the Learner

Shulman describes the ways of teaching within different disciplines as signature pedagogies, noting that "they define the functions of expertise in a field, the locus of authority, and the privileges of rank and standing" (2005, p. 54). According to Bamber "academics seem to be constantly reworking disciplinary norms" (2012, p. 99), becoming learning designers and enacting a *pedagogy as design* approach. Teachers then become designers of knowledge development practices and engagements, where

they aim to allow for opportunities for students to share interpretations of any instructional messages (Kress & Selander, 2012b). Teacher agency is evident in how they choose to design the message, and Kress points at the increase in digital tools which facilitate a multimodal design, offering "the possibility of shaping available resources into coherent compositions which respond to and arise out of the interests of the individual designer" (2018, p. 27). Jewitt (2012b) considers pedagogy as a "practice of design" and argues that the teacher brings together content, technology, and their experience of the social context within which they work. While Jewitt's early work relates specifically to post-primary (pre-university) education, the argument is also valid for higher education, where the lecturer-designer must decide how best to structure learning to provide different opportunities for learning, within the context of the various scholarships as outlined by Boyer (1990) and the development of disciplinary or cross-disciplinary conceptual knowledge.

2.1.3. Concepts as pluralistic and evolving entities

However, while the boundaries of disciplinary concepts are traditionally considered fixed and defined through the disciplinary cannon, in truth, this can only be the starting point for our understanding of concepts, which are situation-based, developmental and participatory (Rosch, 1999; Lacković, 2020). Blundon (2012) argues that our understanding of concepts changed during Vygotsky's time where distinctions were made between scientific and spontaneous (or everyday) concepts. While the scientific concept could be learned through instruction, the spontaneous concept was acquired through sensory and motor experience in the world. However, both constituted true (real) concepts and were rich in diverse socio- cultural, historical references, which would evolve over time. Lacković (2020) suggests that concepts are expansive, flexible, and pluralistic entities, permeated with "sociocultural, structural, agential and historical meanings and influences" (p.132). Within an academic community, the collection of concepts or "a set of specific objects, symbols or events which are grouped together based on shared characteristics, and which can be referenced by a particular name or symbol" (Merrill et al., 1992, p. 6) become an agreed knowledge base for the discipline. Though power relations are ingrained in the development of a system of concepts within this academic community, i.e., from authoritative sources (Bereiter & Scardamalia, 2014), educators should move away from this to consider the plurality of meanings that can emerge from learners' engagement with concepts, based on their experiences and their interpretations. Thus, knowledge development becomes a joint enterprise between students and teachers, the latter claiming some authority based on their prior experience and education but always opening the door for the

inquiry that can shake the foundations of any thinking or theory.

This plurality should extend to a multimodal representation of concepts and the enactment of knowledge as, in that way, knowledge is “made material in a representation” (Kress, 2015, p.45). Traditionally, language was the dominant modality for symbolic representation within many disciplines (Donald, 2002) yet conceptual understanding develops through a combination of multimodal experiences and interpretations by learners. It is in this spirit that Lacković (2020) proposes a view of concepts within academic disciplines that moves beyond just words to an image-concept unity, building on Vygotsky’s notion of holism, i.e., of concepts as a scientific-spontaneous whole to bring together the scientific, environmental, and embodied experiences of knowledge. *Scientific* concepts in the Vygotskian tradition represent the agreed symbolic language of science and *spontaneous* concepts represent the various ways this knowledge is experienced in the educators’ or learners’ world, so that the concept goes beyond just one means of expression (that of symbols) and beyond just one interpretation (that of authority or just teacher). Lacković & Olteanu (2020) also propose a semiotic approach to image-concept synergy as an approach to teaching and learning concepts in higher education. This view challenges an idea of concept-free images or imageless concepts in knowledge development and the methods that support it. Such image-concept enmeshing can be simply observed as a “multimodal concept” (Lacković & Olteanu, forthcoming).

2.1.4. Threshold and core concepts within the disciplines

The proposal to move towards a pluralistic, evolving, and flexible view of concepts challenges the accepted ways of being within the academic disciplines (Jewitt, 2012b) and the agreed system of concepts. For example, threshold concepts are presented as “conceptual gateways” (Meyer & Land, 2005, p. 373), a way of considering key knowledge within the disciplines. Once students understand a threshold concept, their way of thinking is irreversibly changed. Additionally, Meyer and Land (ibid) argue that this shift in thinking is accompanied by an extension of their vocabulary, a new language acquired to reflect on their changed world view. Core concepts are conceptual building blocks that progress understanding of a particular subject, though while “it has to be understood […] it does not necessarily lead to a qualitatively different view of subject matter” (p.4). However, learning in both contexts is experienced at a cognitive and affective level, and the relational nature of learning needs to be considered. The notion that all students would move to a similar point of understanding is also challenged and the excursive and recursive nature of learning is emphasised

(Cousin, 2006). Lacković (2020) discusses students' difficulty grappling with the abstract nature of threshold concepts and argues for including a new approach in pedagogy to connect scientific and everyday concepts using technology tools and visual media. The use of Inquiry Graphics is suggested to engage with threshold concepts, through *Threshold Graphics*, "a holistic, multimodal and dynamic semiotic approach to educational practice" (ibid, p.145). Interrogating the representation of a threshold concept through an image form provides students with an opportunity to explore "relational instances of abstract concepts" (ibid), potentially guiding them towards a better conceptual understanding at the intersection of a concrete and abstract outlook on the world and its phenomena. This plurality of representation pushes students to consider the concept from a critical perspective, noting the relational nature of the concept and encouraging a greater sensitivity to their environment. In this thesis, I am interested in exploring whether the multimodal representation and teaching of threshold and/or core concepts is possible through the screencast.

2.2. The role of digital technologies in teaching and learning

As mentioned above, the introduction of digital technologies provided new tools and approaches to teach conceptual knowledge and enhance the educational experience. Adopting the term "learning design", in a digital context, Conole (2013) considers the "co- evolution of tools and users" (p.90) and examines the relationship between the affordances of digital technologies and user characteristics.

2.2.1. New ways to organise information

The evolution of new multimodal technologies presents numerous possibilities to support collaboration, reflection, creativity, and inquiry, giving "rise to novel ways for information organization, knowledge generation and learning facilitation" (Conole & Alevizou, 2010, p. 12). However, these new digital technologies require teachers to acquire "new skills and new ways of thinking" (ibid, p. 23) to be able to embrace and embed the affordances of these digital tools into their teaching. Principles in instructional and universal design, not initially conceived for digital technologies, became a way of mapping the technology to the intended learning pathways, in an inclusive and accessible manner. Primarily concerned with the "organisation of instruction" (Laurillard, 2009, p. 7), instructional design approaches such as Mayer's (cognitive) theory of multimedia learning (2005) were intended to provide educators with guidance on how to structure multimedia resources to maximise learning. Extending the use of digital technologies which offer "greater flexibility, and multiple

modalities" (Moore, 2007, p. 524) to provide a more inclusive educational experience (Rose & Meyer, 2002), universal design encourages multiple means of representation, i.e., presenting information in a variety of formats to accommodate a diverse population of learners (Matthews et al., 2022a). Digital, networked, and multi-literacies are discussed by Conole and Alevizou (2010) who argue that academic tutors need both the technical proficiency and the knowledge of e-pedagogy (learning with and/ or through technology) to embrace and embed the multiplicity of digital technologies within their teaching.

2.2.2. Lecturer as Learning Designer

The traditional dichotomy, between the separate roles of the instructional designer as pedagogy expert, and the teacher as content expert was challenged by those who called for teachers to become learning designers (Kanuka, 2006; Mishra & Koehler, 2006a). Kanuka (2006) argues that educators should have both knowledge of pedagogies as well as content specific to the discipline to teach effectively, what Shulman (1986) describes as Pedagogical Content Knowledge (PCK). How knowledge is structured within the disciplines and the "uniqueness of each disciplinary culture" (ibid, p.7) are important considerations when choosing the most appropriate instructional methods and PCK exists "at the intersection of content and pedagogy" (Mishra & Koehler, 2006a, p. 1021). As digital technologies evolved, PCK became Technological Pedagogical Content Knowledge (TPCK) acknowledging "the connections, interactions, affordances, and constraints between and among content, pedagogy, and technology" (ibid p.1025). According to Koehler & Mishra (2009, p. 14), TPACK sits "[a]t the heart of good teaching with technology [with] three core components: content, pedagogy, and technology, plus the relationships among and between them".
Understanding these relationships to develop "appropriate, context-specific strategies and representations" (Mishra & Koehler, 2006b, p. 1029) is key to quality teaching. This is one of the reasons why I explore the multimodal screencast and how it is enacted in relation to knowledge content, to propose a multimodal inquiry framework as a tool that can help develop teachers as designers.

Laurillard (2009) challenges educators to think about how digital technologies can support traditional methods in a new context, so that traditional methods get expanded, while Lillejord et al. (2018) argue that "pedagogical quality" (p.45) is the most important aspect of educational provision, regardless of whether innovative digital technologies are used or not, conceding that staff often adapt digital technologies to existing

traditional practices rather than seeking out new ways of teaching with technology. Indeed, pedagogy needs to lead any approach to technology use in higher education. Koehler & Mishra (2009) challenge educators to go further and consider how concepts can be represented using digital technologies; pedagogical approaches which can be supported by different digital technologies; and the potential of digital technologies to help students overcome barriers to learning and develop their knowledge of key concepts in their discipline. They argue that TPCK is "the basis of effective teaching with technology" (p.66). Further, they contend that the simple acquisition of IT skills by teachers is not sufficient to produce effective learning experiences and promote a "learning technology by design" (p.1034) approach in which teachers engage in a process of learning to use digital technologies to meet a specific pedagogical need within their course. However, when Holmberg (2017) uses a Conversation Framework (Laurillard, 2002) to explore teachers' use of technology, he notes that while there was a desire to use ICT for collaboration and practice / modelling between peers, a lack of know-how or digital skills prevented teachers from doing so. Through my work, I hope to provide some ideas and recommendations for lecturers in terms of their preparation of screencasts in the context of online or blended learning and teaching.

2.2.3. Digitally fluent practitioners

The challenge then is for educators to become digitally fluent practitioners, who can take advantage of the affordances of digital technologies to facilitate teaching and learning. Miller & Bartlett (2012) distinguish between fluency and literacy, stating that though they are interrelated, there are distinct differences. Digital literacy is defined as the "capabilities which fit someone for living, learning and working in a digital society" (JISC, 2014). Almås & Krumsvik (2007) offer a more detailed definition in the context of teacher education, suggesting that digital literacy is "the ability to use digital artefacts as an integrated part of [teacher's] pedagogical content knowledge and be aware of what implications this has for teaching [and] learning strategies […] (p. 487). However, digital fluency refers to "the cross- cutting, transecting nature of the skills required to meet the challenge of critical engagement with online information: traditional critical thinking skills, but also internet-specific technical knowledge and ICT-specific competencies" (Miller & Bartlett, 2012, p. 38). Similar to becoming fluent in a language, digitally fluent teachers are competent in designing content, constructing knowledge, and communicating ideas in a digitally connected world (Chigona, 2018), knowing which digital tools to use to communicate their intended message.

Alongside digital literacies, the importance of other literacies was highlighted as the

media of communication was applied in higher education. Adopting the definition of literacy provided by UNESCO (2023) as a starting point, i.e., "the ability to identify, understand, interpret, create, communicate and compute, using printed and written materials associated with varying contexts", I argue that the notion of literacy must move beyond language, as claimed by Tan et al. (2020), to include other modes of communication and other modes of representation, since communication practices have changed significantly.The development of multiliteracies (Cope & Kalantzis, 2009; Selber, 2004; Unsworth, 2001), media literacies (Badia, 2013), critical media literacy (Kellner & Share, 2005, 2019), and information literacy (Head & Eisenberg, 2010; Williamson et al., 2007) were (and still are) encouraged, however these diverse communication literacies are rarely embedded and explored in higher education across disciplines. Rather, they remain within distinct disciplines, although the teaching of any discipline requires a level of broader literacy knowledge and skill that goes beyond linguistic or numeric literacy and should consider the multimodal complexity of what we need to learn.

2.2.4. Critical Literacy and Critical Graphicacy

While literacy, numeracy and articulacy are familiar constructs in education, Eutsler (2021) makes the case for the inclusion of visual literacy in teacher education and Lacković (2020) reflects on the need to apply critical graphicacy (Roth et al., 2005). Building on Balchin's (1972) concept of graphicacy, Danos and Norman (2011, p. 103) consider graphicacy as "the ability to communicate using still visual images, such as graphs, maps, drawings etc. drawings, etc." Critical graphicacy encourages us to interrogate the visual representations of the world, and to identify "the intent and the intentionality" (Lacković, 2020, p. 109). The need for this critical inquiry of photographs was argued by Goldstein (2007) who contested that all photos lie, and that the viewer should question the extent to which deviation from reality is acceptable to them to answer the question they ask. Kress & van Leeuwen (2006) also make this point and discuss the questions of truth and reality as they are represented in different modes, noting that we trust some modes more than others, in particular the visual mode. However, we know now that digital technologies allow for substantial modifications of visual representations, as exemplified in the Instagram vs Reality dichotomy discussed by Tiggemann & Anderberg (2020). Kellner & Share (2005) propose that teaching critical media literacy can encourage "students to learn from media, to resist media manipulation, and to use media materials in constructive ways […]" (p.372).

While critical media literacy is extended to all modes, critical graphicacy encourages

students to move beyond considering images as “exposition tools” (Lacković, 2020, p. 88) used to illustrate a point. Instead, they are invited to examine the image more closely, asking questions to enhance their understanding of the associated concept. Hallewell & Lacković (2017) call for the adoption of critical graphicacy within the traditional setting of the higher education lecture. Their analysis of 22 lectures across 16 universities in the UK revealed that only 9.7% (n=14) of the 145 photographs used in the slides invited students to interrogate the photographs either partially or as a whole. In a world of hyper-visuality (Lacković, 2020, p. 443) critical inquiry is promoted to explore the how these signs operate in a particular historical or social context. In addition, it is needed to foster students’ critical engagement “by exploring the three places of meaning-making: production, consumption and the photograph itself” (Rose, 2012, as cited in Lacković, 2020, p.1175).

2.2.5. A participatory approach to online teaching and learning

As digital technologies become more pervasive, and teaching and learning extends to the blended and online environment, the participatory nature of learning is foregrounded in pedagogical approaches to digitally mediated teaching and learning such as the Community of Inquiry (CoI) (Garrison et al., 2000). Perceived as a “collaborative, constructivist perspective on the teaching and learning transaction” (ibid, p.92), this approach focuses on a teaching and learning environment which includes critical reflection, community building and “directed facilitation” (Garrison, 2007, p. 67). The design of instructional resources and activities should include these key elements, and since web 2.0 technologies are multimodal (Herring, 2015), newer models for blended and online teaching and learning should build on the CoI model to incorporate multimodality, such as Picciano’s (2017) Multimodal Model.

This resurgence of participatory approaches to teaching and learning is accompanied by a relational pedagogy and is in part a response to the impact of a neo-liberal “uncaring marketized HE system” (Gravett et al., 2021, p. 1) of higher education. Relational pedagogy emphasises the caring connection between teacher and students and students and their peers, which needs to be established if meaningful learning is to occur (Bovill, 2020). Aspelin (2020) reports on an intervention study with pre-service teachers, in which their relational competence was explored. The study concluded that participants’ relational understanding improved because of the intervention and the focus on working towards a relational pedagogy. The importance of a relational pedagogy was underlined during the recent remote teaching period, associated with Covid-19. Hatt and Davidson (2022) reflect on the implementation of a relational

approach during the pandemic and conclude that by recognising and acknowledging the contexts of both educators and learners, they could support learners better. Recently, relational pedagogy has been expanded into a pedagogy of mattering (Gravett et al., 2021), which includes the care and consideration not only for other humans (teachers and learners) but the environment, built and natural, animals and things that constitute our lives. In that sense, digital technologies are specific representational artefacts that can bring in the environmental and material aspect of where any knowledge becomes situated and enacted.

This relational and reflective capacity should also extend to our relationship with technology and how it impacts on our interactions with the world, such as in the latest proposition of relational and multimodal higher education by Lacković and Olteanu (forthcoming). Such a relational approach to theory and practice in higher education explores how knowledge and concept development relate to different aspects or modalities of life – social, digital, and environmental, underpinned by the ethics of care (ibid.). The approach I adopt acknowledges the materiality that is embedded in media as a form of representation through its multimodal affordances.

2.2.6. Sociomateriality of Digital Technologies

In 2005, Siemens proposed "a learning theory for the digital age" (Siemens et al., 2005, p. 1) arguing that technology has altered the way we learn. Orlikowski (2007) considers the role of technology in everyday organisational contexts, differentiating between a 'techno-centric' perspective of technology adoption, which assumes that technology is "exogenous, homogeneous, predictable, and stable" (p.1437) and a human-centred perspective, which focuses on how humans interact with technology, grounding its use in a sociocultural context. She argues that the social and the material are "constitutively entangled" (ibid) i.e., inextricably linked, and challenges the idea that one can exist independently of the other.

This "embodied entanglement" (Gourlay, 2021, p. 60) that is the social and material is often ignored in higher education (Fenwick & Edwards, 2016) though educators clearly use materials as part of their embodied academic practice (Gourlay & Oliver, 2016). This extends to the lecture, which Lacković & Popova (2021) consider as a multimodal sociomaterial performance. Challenging the conceptualisation of the lecture as a "mainly verbal instruction method" (p.532), the authors call for a rethinking of the lecture as an assemblage of modes which convey sociocultural practices and ideologies. In a similar vein, Fenwick (2015) suggests that *"*all objects and material settings embed a history […] in the negotiation of their design and accumulated uses"

(p.87). Digital technologies are the material embodiment of sociocultural requirements and are constantly being updated based on our interactions with them. With this in mind, I consider the sociocultural character of the multimodal screencast and the embodied nature of digital knowledge practices.

Finally, contemporary posthumanism calls into question human exceptionalism claiming it is no longer possible to "define humanity as an essence […] which exists independently of the social, the material and the discursive" (Bayne, 2018). Gourlay (2015) characterises digital technologies as "agentive, meaning-making and transformative" (p.498) and considers this in the context of the new literacy practices in higher education, where nonhuman actors such as digital devices function as mediators to co-produce a "posthuman assemblage" (p.497). I argue that as the meaning-making processes of lecturers in the design of screencasts are considered, the agentive nature of these technologies must also be explored, to reveal whether the affordances of digital technologies influence how the lecturer designs the screencast.

Posthumanism in education calls for a rethinking of the "humanistic educational privileging of agency and cognition" (Bayne, 2018) and contends that we can no longer separate human subjects and the objects of knowledge. I find some inspiration in these ideas through connecting digital media affordances of screencast lectures to teachers' intentions and conceptual development.

As our understanding of the role and impact of digital technologies on teaching and learning evolves, we need to explore how meaning-making practices are embodied in the myriad multimodal resources we encounter, in particular in education. This need informs my interest in the screencast and its multimodal affordances, as outlined below.

2.3. Using screencasts and/or pre-recorded videos in teaching and learning

From a teaching and learning perspective, the multimodal affordances of screencasts were quickly identified as beneficial, particularly as the conversation around new approaches to learning in a digital age were developed (Goodfellow & Lea, 2013). The integration of this technology into teaching practice is often coupled with a desire to increase students' digital literacy practices. Hafner (2014) reports on students' use of multimodal texts to develop students' digital literacy as well as their language competence. Students conducted a simple science experiment and reported their findings using a multimodal documentary. Using a multimodal approach for language learning, this study identifies the potential for improving digital literacy as well as "orchestrating semiotic resources in various modes in order to make meaning through

multimodal ensembles" (ibid p.682). The use of screencasts for the provision of rich feedback also features prominently in the literature (see Cranny, (2016); McCarthy, (2015), Vincelette (2013) for case studies, and more recently during Covid-19, Fang & Wickersham- Fish (2020)). Here, lecturers use the affordances of the screencast to provide students with feedback in multiple modes, through the audio-visual annotation of the work submitted. Students seem to appreciate this mode of communicating feedback, pointing to the benefit of seeing and hearing the feedback from the lecturer (Harney, 2017; Robinson et al., 2015).

The development of higher order skills such as problem solving, analysis, judgement and critical thinking are increasingly possible with the inclusion of multimodal assignments. In Hafner's example above, students are required to choose the most appropriate modes to communicate their findings to a specific audience. Dusenberry, Hutter, & Robinson (2015) showcase assignments that challenge students to "communicate multimodally" (p.300), encouraging them to "think deeply about the inter-play of information and design" (p.310).

However, the main function of the multimodal screencast remains its use as an instructional aid for knowledge development. Explaining difficult concepts (Galligan & Hobohm, 2013; Miller & Zhao, 2017; Powell & Wimmer, 2015; Tunku et al., 2013) or presenting educational material for the flipped classroom accounts for a large part of the literature on the use of screencasts in higher education and was especially true during the recent remote emergency teaching period. Gröblinger et al. (2022) reflect on the significant increase in the use of videos in higher education during this period, as educators looked for an alternative to the bricks and mortar classroom during Covid-19.

A qualitative study of students' views of screencasts for teaching how to use a GIS (geographic information system) was conducted by Yıldırım (2021) during Covid-19. Results indicated that while students appreciated the ease of use and availability of the screencasts, the missed opportunities for interaction with the teacher were highlighted, as well as the didactic method of presenting theoretical information without attempts to engage the students. The author provides practical solutions such as not presenting theory in a screencast, keeping the time short or increasing the visuals. I hope to provide lecturer- designers with additional guidance on adopting a multimodal inquiry approach with screencasts to develop students' knowledge within their discipline.

Chapter 3: Developing a multimodal inquiry framework

This chapter introduces multimodality as the theoretical and conceptual approach to higher education that I adopt in this thesis, which seeks to understand the meaning-making practices associated with the process of creating and using multimodal screencasts to teach disciplinary concepts. Following this it presents a new conceptual framework, developed as part of this research, to examine the multimodal composition of the screencast.

3.1. Multimodal meaning-making practices in HE

Many of the frameworks discussed above originate in the domain of learning sciences. However, I highlighted that there has been a shift in the perception of knowledge development through approaches such as multimodality, sociomateriality, and pedagogies of mattering as specific forms of relational and multimodal higher education. As little is known about how screencasts are *designed* for the purpose of pre-recorded lectures and how meaning is made within the screencasts which connects to knowledge development and learning goals across disciplines, I turn to the field of semiotics. Semiotics is a study of semiosis or, in other words, meaning-making practices, and edusemiotics positions it in the context of education. The key element of semiosis is a sign as explained in the section below. I chose to examine the multimodal screencast through the lens of Edusemiotics, since I wanted to explore the meaning-making practices and semiotic choices of the lecturer- designers who created the screencasts, using a multimodal approach. The screencast in this sense is interpreted as a multimodal sign of learning and I am interested in how lecturers use this sign and its multimodal affordances and how they link it to the concepts they are teaching.

3.2. Theoretical approach: Semiotics, Edusemiotics & Multimodality

3.2.1. Semiotics

Since Edusemiotics stems from social semiotics I begin this section with a brief overview of semiotics, which is rooted in a pragmatist ontology.

Semiotics is the study of signs and symbols. Much of the work on semiotics stems from two traditions, that of Ferdinand de Saussure, a Swiss linguist (1857-1913) and Charles Sanders Peirce, an American philosopher and scientist (1839-1914). This thesis adopts Peirce's semiotic views.

Saussurian semiotics identified language as a system of signs, with an "arbitrary union"

(Crotty, 1998, p. 196) between signifier (or form) and signified (idea or concept). Saussure distinguishes between the system of language (*langue)* and *(parole)* speech, noting that the former is a system "shared by all speakers of a language" while the latter is "an individual speech-act in which language as a system is embodied" (ibid, p.198).

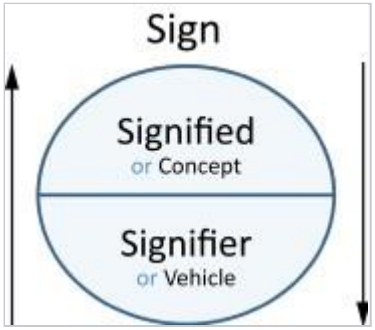


Figure 3:1: A self-contained dyad (Nellhaus, 1998)

The dyadic sign in Figure 1, emblematic of Saussurian semiotics is the result of the association between the signifier and the signified. The signified takes precedence over the signifier, since the signifier does not hold value, it is merely the material/physical form of the sign, which can be seen, heard, touched, tasted, etc. According to Saussure (1983) the value of a sign depends on its relations with other signs, and he points to the arbitrary nature of the sign, within a system which is only ever temporary.

However, Peirce adopts an alternative approach to the sign. Where de Saussure only considers the linguistic structure of the sign, Peirce introduces the notion that the sign exists in respect of something beyond its word form, referring to this as the Object.

For Peirce, the sign

"… {representamen} is something which stands to somebody for something in some respect or capacity. It addresses somebody, that is, creates in the mind of that person an equivalent sign, or perhaps a more developed sign". (Peirce, 1931-1958, 2.228 as cited in Mingers & Willcocks, 2014, p. 11)

Peirce identifies semiosis as the process of testing and refining signs to lead to a more advanced understanding. The evolving nature of our understanding of signs supports the development of knowledge as we investigate and engage more meaningfully with signs. For educators it is important to note that while the Object of the sign in education (e.g., texts, diagrams) relates to either concrete or conceptual knowledge, its interpretation may be varied. Learners may not be familiar with either the form the sign

takes (Representamen) or the what the sign stands for (Object). Importantly, the form presented may not be the best option to represent the object in its totality. For this reason, multiple representation research in Psychology (Ainsworth, 2014; Rau et al., 2017) considers that learning develops best through different forms of representation of the object. Even though we may define it, language can be vague, since its meaning can differ depending on what we take the object to be and flexible, meaning different things in different contexts. Since one form cannot represent the object in its totality, we need to offer a diversity of forms in learning.
Multimodality allows us to do this.

Peirce's triadic sign *stands in respect of something to somebody or some mind* and is divided into three categories: firstness, secondness, and thirdness.

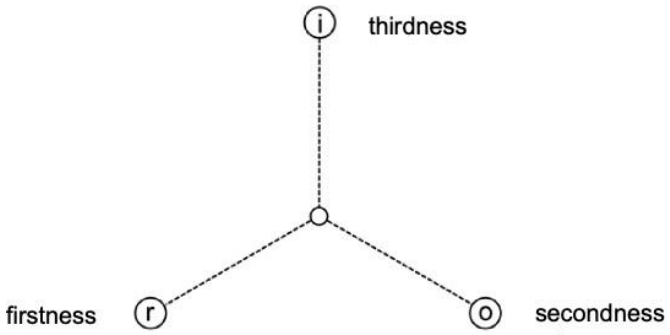


Figure 3:2: Peirce's basic sign structure (Chandler, 2017, p. 31)

Firstness relates to the Representamen, i.e., the form the sign takes, while Secondness relates to the Object, i.e., what the sign stands for. Thirdness relates to the interpretant, i.e., what sense is made of the sign and contains firstness and secondness (Olteanu & Campbell, 2018, p. 251). The inquiry graphic figure introduced in Chapter 1 builds on this triadic sign model turning it into an analytical outlook. Peirce provides a typology of signs to attempt to explain the sign as an understanding of the relationship of an object and the modes of representing that object. A *symbol* (symbolic sign): the representational form or sense/ representamen does not look like the object which it represents, its connection is agreed. The relationship must be learned (e.g., flags, traffic lights, words, signs for hazardous chemicals, etc.). An *icon* (iconic sign): the representamen has some of the qualities of the object which it represents, so they are connected based on the principle of similarity or iconicity e.g., an outline drawing, metaphor, can be also a photograph. An *index* (indexical sign): the representamen is directly connected to the object by the virtue of some existential connection e.g., photograph, natural signs (smoke as a sign of fire). The photographic sign in particular

is interesting since in communication it acts as index-icon- symbol: it can be argued that it has existential connection to the object it shows but it also resembles it and it adopts assigned meanings in communication (e.g., a visual metaphor, a photograph used to represent something). Signs, such as the screencast, which is the focus of this thesis, can include a combination of all three modes (Chandler, 2007) and are always active (Nellhaus, 1998), in the interaction between the sign-maker and the interpreter.

3.2.2. Edusemiotics

Before discussing edusemiotics, it is initially worth considering social semiotics, as a branch of semiotics, which firmly positioned semiotics as a form of inquiry and learning inquiry mainly in school settings. This branch of semiotics explores social practice and tells us about the "processes of sign-making in social environments" (Kress, 2009, p. 59), indicating that sign-makers create signs, remaking "concepts and 'knowledge' in a constant new shaping of the cultural resources for dealing with the social world" (ibid, p.62). How a person interprets a sign depends on their interaction with and experience of the world. This is relevant for education since teachers interpret resources for the preparation and interpretation of presentations in their teaching practice, while learners also interpret the resources and messages they encounter. My thesis focuses on the former, i.e., teachers' interpretations and how they are represented in the screencast in the context of higher education, which is explored much less than primary education.

Jappy (2013) argues that everyone's interpretation is unique and differential and there is always an element of cultural convention involved in how a person interprets a given sign. The social dimension of semiotics points to signs that are based on conventions that we must learn to read, as well as social structures within which we are situated. If semiosis (the process of meaning-making) is studied in isolation from its context, "this is bound to lead to an incomplete account of social causation and therefore risks committing one or more kinds of reductionism" (Fairclough et al., 2002, p. 2).

Given the importance of understanding the sociocultural context of signs, it stands to reason that in an educational context, where we require our students to engage with signs that represent conceptual knowledge within the disciplines, we should examine the situated nature of the sign from the learners' (and the teachers') perspective. As Stables and Semetsky (2015, p. 6) argue:

"Edusemiotics is a study of signs in the context of education broadly understood as encompassing the whole of human, and perhaps beyond-human, experience which

can never be taken in isolation from the environing, sociocultural or natural world".

It challenges the existing Cartesian dualism (mind-body or verbal-visual), that is the supremacy of product over process within an outcomes-based education system (Deely & Semetsky, 2017) and "promotes a pluralistic, synthetic and not just analytic approach to educational philosophy" (Stables and Semetsky, 2015, p.6), valuing knowledge as a process. Danesi (2010) references Peirce who states that there are two parts to the semiotic process, know-how and knowledge. The former requires "creativity and imaginative processes" (p. x) to interpret and mediate signs, while the latter signifies the result. Following this reasoning, I am interested in the processes involved in screencast meaning making that the lecturers engage in to support learners in developing knowledge. Therefore, my investigation is teacher-centred rather than student-centred as I focus on teachers' meaning making and decision making with regards to conceptual learning goals.

Importantly, if we consider the educative process as something that happens over time in a semiotic way, we can turn our attention to the semiotic engagement that forms part of this process. This semiotic engagement exists in "using, responding to and interpreting signs in everyday life" (Olteanu & Campbell, 2018), an argument put forward by Stables (2010) that we learn not just within the confines of formal education, but also from our experience of everyday life, since "all of life is, in a broad sense, educative, and learning is ubiquitous" (Semetsky, 2010, p. 21). Education then is seen as the evolution of semiotic consciousness, engaging with, and learning from signs, situated in life, in experience and in educational practice" (Deely & Semetsky, 2017a, p. 216). Pedagogy, according to Deely and Semetsky (ibid) should aim to enrich experience with meaning and significance, taking note that the interpretation of these signs is subject to evolution and the development of knowledge. As we learn more, the signs and semiotic systems develop, "[i]n use and in experience, its meaning grows" (CP 2.302, 1898, as cited in Nöth, 2014, p. 12), so that the meaning of signs does not remain static but is open to the dynamical interactions with the surrounding world. Edusemiotics is an "open-ended practical inquiry that does not aim to attain finite and indubitable knowledge" (Deely & Semetsky, 2017, p. 216).

In this research study, it was important to note the synchronic nature of the screencast, created at a particular moment in time, in a particular sociocultural context. However, the diachronicity of the signs used within the screencast was also explored with participants. The use of an Inquiry Graphics Framework (Lacković, 2018) which facilitated closer inquiry as critical and creative reflection on the multimodal signs of

knowledge through meaning making analytical steps. This approach was developed for deeper reflection on meaning making at the intersection of visual media and conceptual knowledge development, hence it provided lecturers with a means to investigate their own cognition of the signs they presented to their students. The *semiosphere* (Lotman, 1991, as cited in Semetsky, 2010), into which we are born determines how we view the world around us. We learn, through a process of semiosis, how to mediate signs to negotiate meaning, to "gain access to the historically produced knowledge repertoire" (Semetsky, 2010, p. x) of our culture.

Stables and Semetsky (2015) argue that in learning, meaning is dependent on Conditioning (how a person has reacted to the sign in the past) and Context (the context in which the sign is presented) and the outcomes are always both varied and unpredictable. If we approach learning from a semiotic perspective, we will need to recognise the unpredictability and uncertainty of outcomes, i.e., we can never know for certain how students will respond to a situation. However, familiarity with a student's sociocultural context, as well as their present circumstances, will provide teachers with valuable insights to create opportunities for students to respond positively to the teaching event, according to their own individual contexts. The importance of the relational aspect of teaching is evident here, along with educational approaches which recognise the legitimacy of students' meaning-making processes. In this thesis I aim to explore how promoting a semiotic perspective in teaching can contribute to an advanced understanding of conceptual knowledge within the disciplines.

Finally, university educators will argue that they already use signs as instruments in their teaching, but Nöth (2014) contends that these can only be understood if they become "icons and indices in dicents (propositions) and arguments" (p.16). However, the iconicity as an aspect of meaning making and learning, aside from being a marker of visual similarity has not been given much attention. It is discussed by Olteanu & Campbell (2018) asserting that there is a move away from the reliance on symbolic accounts of learning "to recognize more fully the embodied and sensory foundations of indexicality […] and iconicity' (p.254). That is why it is useful to understand learning resources as complex signs that embed icons, symbols, and indices, which is also the main character of inquiry graphics introduced later.

Edusemiotics is valuable for this present study to understand how teachers aim "to communicate [concepts] by means of signs" (Nöth, 2010 p. 1, in Semetsky, 2010) and how knowledge may be gained through a continual process of interpreting signs. It is also one of the approaches within which inquiry graphics and the proposed multimodal

inquiry framework are situated.

3.2.3. Multimodality of higher education

In education, as in the broader context, signs are represented through a variety of modes. Kress (2014) defines modes as "socially shaped material resources, such as speech, gesture, writing, dance, image, and movement. They are the outcome of the characteristics of a material (such as sound) and of its 'affordances', shaped in the ceaseless social– semiotic work of fitting this material to the 'needs' of specific communities, over long histories of semiotic work" (p. 142).

Multimodality is "an inter-disciplinary approach drawn from social semiotics that understands communication and representation as more than language and attends systematically to the social interpretation of a range of forms of making meaning" (Jewitt, 2013b, p. 250). It refers to the way in which different kinds of meaning making are combined and integrated into a "multimodal whole" (Jewitt et al., 2016, p. 2) or a "semiotic resource […] shaped over time by socially and culturally organized communities" (ibid, p.15). As multimodal technologies become more ubiquitous, a shift in the use of resources which use multiple modes has emerged. Jewitt (2012b) contends that technology can reshape how knowledge is communicated, using a multimodal approach. As students continue to integrate multimodal tools in their everyday lives, educators are encouraged to consider the use of multimodal semiotic resources, to allow students "more agency and creativity in their education" (Bayne, 2008, p. 173).

Archer & Breuer (2016b) provide an overview of multimodality studies in a variety of higher education disciplines e.g., Science (Roehrich, 2016), Civil Engineering (Simpson, 2016), and Accounting (Alyousef & Mickan, 2016) amongst others. Recognising that the traditional notion of literacy extends beyond language, these authors demonstrate how frameworks originally applied to the field of linguistics (e.g., Halliday's metafunctions (Halliday, 1993)), can be used for other modes. Additionally, the choice of modes and the role they play is dependent on the "disciplinary culture" (Archer & Breuer, 2016, p. 12) within which they are embedded. The chapters cited above demonstrate the situatedness of the meaning-making process, both from the designer and the recipients' point of view. However, this collection on multimodality in higher education does not tackle a more universal multimodal approach to conceptual knowledge and development. Lacković (2016) provides an example of such practice by discussing students' reflections on the pedagogical value of using multimodal artefacts

to learn about a concept in a postgraduate online course in education. Findings suggest a tension between the focus on a traditional mono-modal assessment and newer ways of communication through various modes, together with an appreciation of the deeper learning that happens when images are inquired. The author argues for an acknowledgement and application of other modes of expression than language, in particular images, as "equal, challenging and legitimate" (p.159) in university learning.

The need to move away from logocentrism

In higher education traditionally, language was the dominant mode through which curriculum knowledge was communicated (Jewitt, 2012b), except for the visual arts disciplines. Here, other modes such as image, gesture, dance, and sound are foregrounded, with language taking a subordinate role. However, the move away from a logocentric approach to presenting content is evident in several research studies and the argument for including different modes is based on the different potential they offer for meaning making (Jewitt et al., 2016). As such, students' engagement with the content may depend on the mode in which the information is presented. In 2003 Carey Jewitt introduced a multimodal framework for the analysis of computer-mediated learning resources. Central to this work is how the chosen semiotic modes represent knowledge and more specifically, how the move from one mode to another reshapes curriculum knowledge. Focusing on "still image, colour, movement and gesture, writing, sound-effect and speech" (Jewitt, 2003b, p. 280), Jewitt explores the use of computer mediated resources in post-primary school English, Maths and Science. Noting the significance of the choice of mode on how knowledge is represented, Jewitt argues that designers of educational resources should engage critically with the process to understand how "different modes offer different sets of semiotic resources and these resources shape meaning in particular ways" (p.280).

The choice of modal resources, of genre and of other forms of textual organization are considered questions of design (Kress, 2015). According to Kress (ibid), to decide which mode was most appropriate to communicate the intended message, the rhetor would need to establish who the audience is, what their level of knowledge is, and what the semiotic requirements to be communicated are, i.e., is it better to show a diagram of a network rather than explain it in a narrative? These choices reveal an epistemological commitment on the part of the designer and can be explored within research studies on multimodality in higher education. For this thesis, it could explain the reasons for the choice of mode to represent conceptual knowledge within a specific discipline.

Multimodal technologies

The range of disciplines which include a multimodal approach to teaching and learning has steadily increased in recent years. Multimodal technologies such as Voicethread (Dooly & Sadler, 2013; Dugartsyrenova & Sardegna, 2017) are increasingly used in second language education to develop learner proficiency. Breuer and Archer (2016) present a collection of chapters showcasing how a multimodal approach is used in disciplines such as Science (intersemiosis as a way of building new meaning); Accounting (representation of knowledge through graphs and tables); and Engineering (relationship between modes within a civil engineering drawing). The authors suggest that "multimodality manifests in multimodal pedagogies" (p.1) and requires students to have multimodal competencies in order to complete the innovative assignments which result from this new approach. Additionally, more recent research in higher education has explored the use of multimodal approaches in disciplines such as academic writing (Donnelly et al., 2022); essay composition (Smith, 2017); assessment of multimodal literacies (Tan et al., 2020; Wawra, 2018) and TOEFL (Erfanian Mohammadi et al., 2019), while the use of digital touch communication (Jewitt et al., 2022; Jewitt & Leder Mackley, 2019) explores the sensory touch as a means of communication within the context of multimodality. Multimodal platforms such as websites are explored for their meaning-making potential (Djonov et al., 2015), while platforms which foreground the visual mode are increasingly explored for their meaning-making potential as these platforms become more integrated into our daily lives. Poulsen (2018) analyses the diachronic development of Instagram from a social semiotic, multimodal perspective and provides a useful insight into how the social software has "facilitated structured visual meaning-making" (p.121), while the hierarchical relationship between text and image is dismantled within social media sites such as Snapchat by Bartels (2017). Zhao and Zappavigna (2018) explore the use of social photography in female visual blogging.

Visuality is also becoming increasingly important in the wider education field as researchers explore the role of semiotics in understanding how meaning is made using technology. One of the most widely used technologies in education, Microsoft PowerPoint, has been the subject of several semiotic analysis studies. Zhao and van Leeuwen (2014), Zhao, Djonov and van Leeuwen (2014) and Djonov and O'Halloran (2013) analyse PowerPoint as a semiotic technology, "a technology for meaning making" (p.9), while Hallewell and Lacković (2017) explore the role of images within a PowerPoint presentation, arguing for the need to explore photographs from a semiotic perspective.

Within the domain of teacher education, multimodality challenges trainee teachers to view teaching and learning from different perspectives. In language education, a multimodal perspective has provided a way to rethink how trainee teachers teach language (Early et al., 2015), or teach online (Satar & Wigham, 2017). Multimodal approaches to teacher education also challenge trainee teachers to move beyond language to see how other modes might be used within an educational context. The use of metaphors to encapsulate their views of teachers and teaching (Hamilton, 2016; Thomas & Beauchamp, 2011); photographs to explore their beliefs about their students (Stockall & Davis, 2011), and visual images to 'improve practice' (Bailey & van Harken, 2014, p. 241) are examples of how multimodality is gaining traction within the field of teacher education. Thompson (2008) introduces multimodality for pre- and in-service teachers taking a literacy module noting that "each content area is engaged in multiple forms of literacy through various modes of meaning making" (p.144) and encourages teachers to consider how to incorporate multimodality into their teaching to connect with adolescents' lives outside the classroom. This was particularly important during the recent remote emergency teaching period due to Covid-19 where the move towards a multimodal approach to teaching and learning was evident. Educators redefined their professional boundaries to develop a "semiotic assemblage" (Gourlay et al., 2021, p. 380) of multimodal, human, and non-human actors to help them teach online and students developed their multimodal digital literacy skills to produce evidence of skills or knowledge (Gu & Huang, 2022) for this new environment.

The multimodal student is the focus of a collection of chapters on 'Multimodal Literacies and Emerging Genres' edited by Bowen and Whithaus (2013). Here Bowen and Whithaus argue that what it means to be literate in the world today is changing and as technology becomes more embedded in academic programmes within higher education, "multimodal composing" is a "dynamic way of thinking about expressing ideas" (p.7) and responding to students' new literacy practices (Lankshear & Knobel, 2011; Miller & McVee, 2012) which incorporate technology regularly.

The studies discussed above explore the meaning-making potential of a combination of modes, whether these are visual, linguistic, touch, audio or other. But how does one know which mode to choose and what modes to combine? The affordances of each mode are discussed in the following section, to provide an insight into the potential of each for meaning making, laying the foundation for the analysis of modes within the screencasts which is part of this research study.

3.3. Defining the mode

In this section I consider the mode itself, as defined by Kress (2014) earlier in this chapter, followed by the affordances of each mode. According to the New London Group (1996), the five modes of communication are visual, linguistic, spatial, gestural, and aural. While visual refers to "still or moving image, sculpture, craft (representing meaning to another); view, vista, scene, perspective (representing meaning to oneself)" (Cope & Kalantzis, 2009, p.178), the linguistic mode includes the written or spoken word (though both became separate modes in Cope and Kalantzis, (2009)). Spatial representation refers to the positioning of elements within the environment, while gestural includes the way in which movement is interpreted. Finally, the aural or audio mode focuses on music, ambient sounds, noises (ibid, p.178). For this study, the gestural mode was omitted, since the screencasts did not include a webcam which would allow for the analysis of gestures. This resulted in a focus on visual, linguistic, spatial, and aural modes present within the screencast.

3.4. Affordances of modes

The term *affordance* was originally coined by psychologist Gibson (1979) to describe an "agent-situation" interaction, in which affordances are "all action possibilities" (Mode, 2012). Norman (1988) further developed this definition, describing an affordance as "the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used" (p.9) referring to the design of objects. In the context of multimodality Kress (2010) considered the affordances of different modes for meaning making, which are dependent on the material, historical, cultural, and social ways in which the mode has been used (Mode, 2012).

As Jewitt (2003a) outlined, modal affordances play a significant role in the representation of knowledge. Image, Text, Speech, and Sound (Audio) are semiotic resources for meaning making, therefore lecturer-designers need to consider these affordances in the design of their educational resources. However, while these modes have existed independently for a long time, digital technologies quite easily facilitate multimodal compositions, or modal ensembles (Jewitt, 2013b). Here, each mode is considered as partial representative of the meaning in a semiotic whole (Kress, 2015) and most notably, in a multimodal ensemble, language is divested of its position as the main carrier of meaning. Moving beyond a reliance on language content is displayed in different ways (Pinar, 2019).

Kress & van Leeuwen (2006) highlight the ways in which production technologies (to include non-digital such as pencil and paper or a musical instrument) enter the semiotic process of

meaning making, through the kinds of means they facilitate, i.e., their affordances. Van Leeuwen (1999) provides examples of this using image and sound, “in the semiotics of sound you cannot represent ‘disharmony’ without actually having two ‘voices’ […] clash with each other” (p.191). The materiality of the medium is highlighted, underlining the affordances, and meaning-making potential of these. To understand the potential affordances of each mode, the following section will examine more closely each of the four modes which are included in the screencast.

3.4.1. Visual Mode: Affordances

O’Toole (2010) explores visual art for its representational, modal, and compositional meaning, while Kress & van Leeuwen (2006) develop a grammar of visual design to ‘read’ images for their meaning-making potential, noting how “visual structures point to particular interpretations of experience and forms of interaction” (p.3) and “visual communication is always coded” (p.32). Hallewell & Lacković (2017) consider lecturers’ use of photographs in a semiotic analysis of their meaning-making processes. Exploring a range of photographs semiotically, they conclude that this visual resource is “underused and overlooked” (p.1174) as a tool to develop students’ conceptual development in the traditional lecture. They develop a typology of image semiotic articulation to examine the underlying assumptions about how content is presented multimodally, which will be used in this thesis to explore the visual representation of the concept in the screencast. Drawing attention to different visual structures used for conceptual visualisation, Kress and van Leeuwen (2006) highlight the representation of concepts in flowcharts and network diagrams, while also analysing the use of taxonomies to classify images. The idea of elements within an image being subordinate/superordinate within a part-whole structure is dependent on the encoding intention of the producer, i.e., the message they wish to communicate. The use of animation graphics (simulations) provides learners with an opportunity to visualise a process, not “inherently visible” (Betrancourt, 2012, p. 288) or not easily observable. An integrated analysis of the multimodal text is called for, moving away from analysis of each mode individually to considering the combination of modes.

3.4.2. Linguistic Mode: Affordances

Linguistic affordances are considered in the context of the language of the disciplines. Nestlog (2019) proposes that disciplinary language is “a collective concept for the language that qualified participants in a subject culture use” (p.185). In education, content experts use discipline-specific language conventions in dialogue with students, thus initiating them into

the language of the discipline and developing their disciplinary fluency. The choice of vocabulary used to present the subject content is determined by the community of content experts, which is constantly evolving as knowledge within the discipline evolves.

While disciplinary language focuses on the discourse of the academic discipline, disciplinary literacy, according to Shanahan & Shanahan (2012) “is an emphasis on the knowledge and abilities possessed by those who create, communicate, and use knowledge within the disciplines” (p.8). Airey (2011) suggests that disciplinary literacy is different to content literacy, the focus of much of higher education, and encourages content lecturers to unpack the “communicative practices” (p.3) of their discipline to prepare undergraduates for “the academy, the workplace and society” (p.4).

The importance of language is evident in the call from Bovill (2020) to move away from transactional language to a relational language as a means of enacting a relational pedagogy. Aspelin (2019) reports on a project designed to develop pre-service teachers’ socio-emotional competence, through the analysis of teaching sequences, and notes the increase in use of words to describe student emotions following an intervention which explores teacher relational competence. Differentiation competence, described as “a representation of the art or skill of adjusting closeness and distance in interpersonal relationship” (Aspelin, 2015, p. 43) is evidence of the teacher’s position in the shared teaching and learning space and embodied in the language used in a discursive relationship with students. “Joint enterprise” (Adams, 2018, p.14) might be expressed using the pronoun “we” in the teaching, rather than the more transactional and less inclusive “I” or “you”, which increases the social distance between teacher and student. It will be interesting to see if the language used in the screencasts reveals evidence of joint enterprise.

3.4.3. Aural Mode: Affordances

In the research literature, the affordances of audio are highlighted primarily in the context of providing feedback to students (Gould & Day, 2013; Killingback et al., 2019; Rotheram, 2009a). Of particular importance are the tone and emphasis used by the lecturer to communicate the feedback, along with the personalised nature of the message. However, Van Leeuwen (1999) differentiates between speech, music, and sound as semiotic resources. The concept of musical perspective is discussed, and like the perspective of the visual, “both can create relations between the subject they represent and the receiver they address, and in both this is related to distance […]” (Van Leeuwen, 1999, p.14) through perspective (foregrounding and backgrounding) and social distance (intimacy, e.g., the

whisper, informality, e.g., the casual voice, or formality, e.g., the louder, tenser voice). Background / Field sounds (such as the music heard in some of the screencasts) are to be "*heard*", while foreground / Figure sounds (such as the lecturer's voice) are to be "*listened to*" (Van Leeuwen, 1999, p.15 italics in original) - each of these hierarchized using dynamics. Van Leeuwen (1999) also considers characteristics of sound such as rhythm and tempo (stream of sound in measures of equal duration). Where a sound is 'stressed' such as through loudness, pitch, and relative duration, this points to the greatest information value in a specific context.

While Van Leeuwen (1999) contends that the tempo changes quite often in conversational speech, this is often motivated by the speaker who determines what message he wants to communicate. Discourse markers such as hesitations, (e.g., 'em') or emphasis contribute to this speech act and relate to words used to "mark boundaries in conversation between one topic or bit of business and the next" (Erten, 2014, p. 69). Additionally, the value of melodic patterns derives from what the producer wants to achieve. Ascending and descending melodies can energise or relax and soothe listeners, indicating the "semiotic force" (p.106) of the sound, while the pitch range can characterise the emotional styles of different cultures or social groups. Finally, the use of a melodic phrase either as staccato or legato (short separate stabs, or a smooth long line) implies a semiotic articulation. The former, according to Van Leeuwen (1999), is associated with a forceful, bold, energetic articulation, while the latter is linked to a more relaxed approach. Van Leeuwen's analysis of speech is a useful approach to consider how lecturers use their voice to communicate their teaching, either intentionally or subconsciously.

Song lyrics are often used in teaching "as the focus of pedagogical practice" (Werner, 2012, p. 42), either to provide situated examples of a concept, e.g., Levy & Byrd (2011) use music to teach social justice, or Werner 's (2012) use of song lyrics to teach American history. However, examples of the analysis of melodic patterns of music used for teaching are more difficult to find. Rozinski (2015) uses song lyrics and the music that accompanies them to teach political theory, noting that initially he uses song lyrics to introduce the concept, or to demonstrate how a theoretical concept applies to a concrete situation. He also uses the music to reinforce students' memory, citing Levitin (2006) who suggests that the music we listen to is associated or "cross-coded" (p.484) with events in our life. Mental associations with concepts taught using music are recalled more easily according to Rozinski (2015), making them a useful semiotic resource.

Music also evokes an emotional response in the listener and may prompt the recall of

emotional memories or inspire the listener into action (Juslin & Gibran, 2013). Scherer & Zentner (2001) suggest that the power of music to elicit an emotional response is based both on sociocultural conventions and the listener's sociocultural identity. Extending this to an educational context, the use of music to evoke emotions in the learner can be a powerful tool in terms of engagement. De la Mora Velasco et al. (2021) suggest that matching the music used to the tempo of the voice can enhance learner's attention, motivation and engagement with the concepts being presented. Instructional videos often incorporate music, and this can prove quite popular amongst students. In their study, Wong et al. (2019) presented students with three types of video clips, (1) a silent version with background music; (2) a narrated and subtitled version with background music and (3) a narrated video with subtitles and no background music. Their results showed that the most frequently viewed videos were those that were narrated, subtitled, and had background music. Kharisma (2020) reported that over 80% of student respondents to a questionnaire on using screencasts in higher education indicated a preference for music within the videos. While only two of the screencasts included in this research study used music, it is useful to consider the semiotic role it plays for lecturers in the teaching of disciplinary concepts.

3.4.4. Spatial – Design Mode: Affordances

In the context of digital resources for teaching, Murray (2009) argues that the document produced with digital technology becomes a message in itself, communicating "something about the way that same document conveys information, and the way readers use it" (p.66) through its visual design. This points to the potential of digital technologies to change how a message is constructed and the need to consider the design of digital resources in terms of meaning making. The affordances attributed to digital technologies as enablers of the modes mentioned above is a key component of research by Conole and Dyke (2004) who propose a taxonomy of affordances of ICT, which includes amongst others multimodality and non- linear approaches to learning. These are particularly evident in the design of screen-based resources where the limitations of linear structures are removed, and designers can decide on the spatial arrangement of the modal elements. The non-linear nature of visual designs was also analysed by Kress and Van Leeuwen (2006), giving the receiver of the message more autonomy in terms of the sequential structure. Therefore, increased attention to composition and spatial arrangement is necessary if the producer of the message wishes receivers to approach the multimodal text in a particular way. Kress and Van Leeuwen (2006) propose three interrelated systems to relate the representational and interactive meanings of images, *Information value*, i.e., the placement of elements within the image suggests

informational value, *Salience*, i.e., how they attract the viewers' attention (foregrounding or backgrounding) and *Framing*, including, or omitting framing devices to disconnect or connect elements (e.g., lines). These three systems can be applied to the screencast 'frames', to reveal the lecturers' epistemological and pedagogical intentions.

3.5. Multimodal Anchorage: Where Concept and Mode Meet

Different compositional arrangements lead to the realisation of different textual meanings (Kress & van Leeuwen, 2006). Depending on the layout of the composition and the positioning of visual / textual elements, one mode may serve as 'anchor' for the message (p.43). Barthes (1964) distinguishes between anchorage and relay (*l'ancrage et relais)* in relation to the meaning of the iconic (visual) message. Given its "polysemous nature" (p.44), images are open to many interpretations. The use of another mode (e.g., text) to 'anchor' the meaning assists in communicating the desired meaning. Using the image-text relationship within the children's book *Where the Wild Things Are* Yamin & Hassan (2020) describe how several interpretations can be attributed to the pictures included in the book, so the linguistic mode is used to "anchor the certain meaning" (p.1535).

In terms of the semiotic relationship between speech and slide-text is examined by Hallewell & Crook (2020), who propose two relationship styles between modes, i.e., a referent function where slide text is used as an object of reference by the lecturer or a scaffolding function, where the slide text is included in the lecturer narration. Horlacher & De Stefani (2017) also consider the relationship between modes in their study of the use of the French spatial deictic *là* (there) and modal anchorage of the gesture that frequently accompanies it (pointing or grasping), to distinguish from the temporal use of the word to denote a specific time period.

Lacković (2020) introduces the concept of multimodal anchorage to talk about the relationship between pictorial interpretations and concept interpretations within the Inquiry Graphics sign introduced below. Here images offer meaning potential, which "can be connected to the concept superimposed over the picture" (p.70). Viewers can consider interpretations of the image in terms of its relationship with a concept or start with the image and consider how its elements (or indeed the image as a whole) might connect to the concept.

For the present study, I extend this image-concept approach to include additional modes, where an additional mode is used to reinforce the meaning that is presented within the

screencast; the verbal providing anchorage for the visual (Chovanec, 2014) and linguistic mode or vice versa. However, Barthes draws attention to the control exercised by the creator of the image in selecting the anchorage, noting that "anchorage is a control, bearing a responsibility" (1977, p. 156) and that text often had a "repressive value" (ibid, p.157). Through multimodal inquiry of the screencasts, the creator's semiotic choices can be revealed.

3.6. Multimodal Screencasts and Video Affordances

As mentioned previously, Jewitt (2013) argues that each mode is only partial in terms of its meaning-making potential, therefore the combination of modes into a multimodal ensemble is necessary to manage this partiality. The screencast provides such a platform for combining modes to represent a message's meaning.

This chapter charts the landscape of multimodality in higher education. Examining the literature on the affordances of different modalities and how they are used within education, I argue for a multimodal inquiry approach to the teaching of concepts with screencasts. It provides opportunities to interrogate different modes for their meaning-making potential, revealing the intentions of the lecturer-designer and contributes to the development of students' critical media literacy skills. While several studies have provided examples of multimodal inquiry in action, I have not found studies that use a framework to 'inquire' multimodal resources such as screencasts for learning purposes. Therefore, I propose a multimodal inquiry framework, which builds on the Inquiry Graphics approach and the suggested development of this framework into multimodal inquiry by Lacković (2020, 2021), to address this gap. The next section explains the development of this framework.

3.7. Inquiry Graphics

Inquiry Graphics is an edusemiotic/semiotic and multimodal theory and method (Lacković, 2020). Therefore, it brings together the approaches previously discussed. Theoretically, it argues that knowledge happens as an integration between sensory experience and abstracting (abstract concepts and knowledge). In practice, it applies Peirce's triadic sign to explore disciplinary concepts with visual media (or, in other words, graphics). The main point of Inquiry Graphics is to inquire or critically analyse how visual media and conceptual development relate, building on the triadic conception of meaning making and foregrounds students' interpretation as well as their creative and critical engagement with knowledge development.

The term Inquiry Graphics (IG) was coined by Dr. Nataša Lacković and refers to “graphics integrated within concepts or thematic units across educational domains, thus forming integral signs of knowledge development” (2020, p. ix). Lacković (2018) positions Inquiry Graphics within an increasingly multimodal teaching and learning environment, where communication is “complex and layered” (p. 2) and communication acts are fundamentally multimodal (Bezemer & Kress, 2015). While the use of video in educational research provides a rich tool by which to analyse modes beyond language, Lacković (2018) notes that in many cases it is used primarily as a medium for language-based reflection or feedback, rather than as a visual springboard for reflection, creative and critical thinking.

IG can be seen as the use of graphics in higher education pedagogy and therefore a teaching approach. Indeed, Mac Giolla Rí (2020) proposes the use of IG within a social care practice education context to teach and learn critical visual literacy. However, IG can also provide “interpretative guidelines to support researchers in multimodal, edusemiotic coding and analysis of video data” (Lacković, 2018, p. 1). Moving from the analysis of individual elements of a video (micro focus) to a broader question or research concept (macro focus), IG provides a framework for researchers to decode video in the context of a specific research question, through a series of comprehensive analytical steps. Lacković & Popova (2021) use Inquiry Graphics to analyse the sociomateriality of video lectures made available online by ‘top ranked’ universities, while Tyrer (2021) uses IG to analyse multimodal screencasting feedback. Such IG analysis is commonly applied from a micro focus on individual elements within the video to a macro focus on the composition of these elements that are present in multimodal ensembles (Jewitt, 2013a), for the purpose of presenting a specific concept or research question, which provides conceptual focus for the analysis.

IG allows researchers to apply Peircean semiotics to an educational act, in the case of this thesis the act of creating a screencast. The Peircean Representamen relates to the element represented within the screencast – everything that is present in the screencast’s multimodal design, which resembles something in the real world, i.e., its Object. For example, if the screencast displays a word, then this word represents some meaning, if it includes a picture, then this picture represents the element(s) it shows. The Interpretant is essentially the interpretation by some mind, which associates the Representamen with the Object, within their specific context and meaning is made through this triadic sign relation. The table below shows how an inquiry graphics analysis can lead pedagogy or research, which is applied in this study in the methodological analysis of the screencast.

Table 3:1: An example of an inquiry graphic analytical table that embeds a Peircean triadic sign (Lacković, 2020)

Representamen Note and List what you see/hear (through key words, one can identify salient elements observed)	**Interpretant** Describe what you see / hear At two levels of interpretation		**Object** What does the represented mean in this inquiry/research context (how does it connect to learning goal/theme)?
E.g. • Grain of wheat • Milk pack • Lobster	**Denotation (DE) -** Basic description using adjectives, e.g., looks like, feels like, is like…to qualitatively describe the noted elements/ things E.g., Looks like a collage of different food types.	**Connotation (CE)** What does this mean in the given contexts? E.g., A picture of a grain of wheat has been known to represent an allergen.	How does a modality of the screencast (picture, word, voice) contribute to the teaching/development or understanding of the concept? How is this relation made? How should it help learning? How do/can the pictures of allergens help develop the knowledge about allergens?

3.8. Semiotic articulation of concepts in lecturing

There has been a scarcity of studies to explore semiotic articulation of concepts in lecturing where visual media are used in lecture material. As this thesis is interested in the articulation of concepts within the multimodal screencast, semiotic referencing aligned with the inquiry graphics sign as outlined by Hallewell & Lacković (2017) is adopted to analyse the graphic-pictorial elements of the screencast lecture. Ranging from the inclusion of graphic-pictorial elements in the lecture purely for illustrative purposes, to a critical semiotic exploration of graphic-pictorial elements, either by the lecturer or by the students, the categories outlined in the table below are helpful to examine the articulation of concepts through the graphic-pictorial mode. It is important to note that the categorisation of Semiotic Articulation, Interrogation Invitation and Critical Semiotic Exploration can happen for one and the same photograph or visual representation on the slide. Critical Semiotic Exploration (CSE)

represents a holistic approach to analysing images such as photographs for learning in higher education. It is not suggested that CSE happens with every visual media used but is provided as an option for key images chosen by lecturers.

Following on from the analysis of the graphic-pictorial mode, I extend the IG analysis to a multimodal inquiry as proposed by Lacković (2021) to explore the additional modes present in the screencast lecture.

Table 3:2: Semiotic Referencing adaptation (Hallewell & Lacković, 2017)

Representation type (e.g., image)	**Subcategory**	**Descriptor**
Unprobed Representation	Attentional	The image (illustration or photograph) is not *mentioned* in the lecturer's narration of the slide.
	Depictional	The image features in the lecturer's narrative but is not directly referred to.
Semiotic Articulation		The lecturer's narrative references the image or elements within the image in relation to the concept/ knowledge content.
Semiotic Interrogation Invitation		The lecturer invites the viewer (student) to interrogate/analyse the image or some of its elements and related meaning in relation to the concept/ knowledge content.
Critical Semiotic Exploration		The image is analysed critically by the lecturer in relation to the lecture content. This can include Semiotic Articulation and Interrogation Invitation.

3.9. Multimodal Inquiry for Teaching and Learning

Literat et al. (2018) provided a perspective that my study strongly aligns with, arguing that multimodal inquiry should be an integral part of higher education research and scholarship. Citing the iterative research process of "inquiry, analysis, representation and engagement" (p.569) as fertile ground for multimodal inquiry, this group of scholar-practitioners propose multimodal research as a way of "creating opportunities for the inclusion of various ways of knowing and communicating" (p.568). Moving away from a logocentric tradition of paper-

based formats for disseminating scholarly knowledge, Literat et al. (2018) suggest that the profusion of digital technologies enables researchers and scholars to collect, analyse, represent, and disseminate research in a variety of modes, mirroring what happens in the contemporary social world. They also advocate for the inclusion of this new multimodal approach within the classroom, to prepare future scholars for "a context that is supportive, open, flexible and respectful of equity and diversity of knowledge" (p.575). It is also important to note the challenge of multimodality for learning. Bezemer & Jewitt (2010) point to key issues in multimodal research, noting that "too much attention to many different modes may take away from understanding the workings of a particular mode; too much attention to a single mode and one runs the risk of 'tying things down' to just one of many ways in which people make meaning" (p.194).

Lacković (2020) proposes that multimodal inquiry could build on an Inquiry Graphics approach, to foreground a "slow, analytical and semiotic unpacking" (p.16) of information presented in a variety of modes within the context of education and learning. Guided inquiry as proposed by Lacković (2020) supports learners' development in a scaffolded manner, removing the uncertainty associated with non-instructional inquiry-based learning. While the primary focus of the IG approach is on digital photographs, I build on the stated suggestion of a multimodal inquiry and argue that this approach can be extended to other modalities such as graphic symbols, sound (voice and music), language and software.

Studies which use a multimodal inquiry approach are most evident in secondary education (see Johnson & Park (2022) and Unsworth et al. (2019) for examples). However, in higher education there are few examples of multimodal inquiry in practice. Archer (2022) presents a multimodal approach to teaching academic writing to make the process more "democratic and inclusive" (p. 551). Students' multimodal literacies in English Language Learning were the focus of a study from Dressen-Hammouda & Wigham (2022), assessed using a multimodal evaluation grid, focusing on linguistic, aural, visual, spatial, and temporal elements of student-created videos. While the evaluation grid was detailed in its assessment of each of the five modes, it was not made available to students in advance of the design of the videos, limiting their potential to focus on developing their literacy in each of the modes. Morawski & Rottmann (2016) report on the implementation of a multimodal teacher narrative inquiry approach with teacher candidates using journals and resolution scrapbooks. The multimodal activities reported on in this study, which were initially conceived to help them explore their own teacher narratives, were brought forward into their own teaching practice, and helped them to engage students with the curriculum.

While these examples provide an insight into the potential of multimodal inquiry for developing multiliteracies, this thesis proposes a multimodal inquiry approach to the development of students' disciplinary knowledge within higher education. However, this approach must also consider the potential for transmediation and transmodality when multiple modes are used to represent a concept such as in the screencast lecture.

3.10. Transmediation and Transmodal Redesign

Multimodal Inquiry can support learners to consider how content is represented in different ways, examining where transmediation occurs and leveraging "the modal affordances of different mediums" (Smith, 2017, p. 149). Transmediation, a process where meaning is translated "from one sign system to another" through "modal orchestration" (Smith, 2017, p. 140), adds additional layers to the meaning-making potential of semiotic resources.

Examples of transmediation studies include Mills and Brown (2022), who discuss the use of Virtual Reality (VR) in literacy practice. The potential for transmediation is highlighted as learners use the multimodal VR environment to translate stories to a virtual painting, "mapping meaning across non-analogous expression planes or symbol systems" (p.181). Additionally, the multimodal social networking site Pinterest offers students opportunities to use "different modes to make meaning" (Song et al., 2017, p. 40). In the screencast, I am interested in how transmediation can happen as meaning is translated across modes such as from voice to image or from text to image.

Kress (2010) argues that in communication, the interpreter of a message will first engage in semiotic work to create a 'new' version of the message, based on their conception of the world. They will consider questions such as what modes to use, how to represent meaning, the audience for whom the message is intended, etc. to determine their choices. The result is a process of transmodal redesign (Mavers, 2011), i.e., remaking form and meaning within their sociocultural context. Newfield's (2014) transmodal moment focuses on the "multiple transformations that occur in processes of transduction, in materiality, genre, meaning, subjectivity and learning as well as revealing the situatedness of the transmodal semiotic action" (MODE, 2012a). Multimodal artefacts provide opportunities for multiple transmodal moments, as meaning is translated across modes. For lecturer-designers, the task of choosing a mode necessitates a reflection on the meaning-making potential of that mode, and on the possibility of "gains and losses" (Bezemer & Jewitt, 2010) brought about by the choice made and the risk in meaning alteration. Culache (2015) considers transduction in the domain of advertising and identifies the potential of a dominant mode, i.e., "the mode

strategically conceived […] to have a greater impact within the interpretation model" (p.500).

In a multimodal environment, each design choice is accompanied by numerous decisions embedded in the transmodal semiotic action. Lacković (2020) discusses transduction within a "Thinking with Images" Design-Based Research (DBR) project, where learners are asked to select an image they feel represents an assigned concept. Demonstrating criticality and deep reflective thinking, participants revealed their understanding of the concept through their choice of images, which resulted in a complex transduction process. Finding an appropriate image to articulate their concept ideas was often challenging and "imbued with sociocultural meaning" (p.285). In the screencast lecture, I am interested in exploring the combination of modes used to represent the concept and the potential for transmediation and transduction. Equally, if lecturers are aware of the need for a combination of modes to explain a concept, it is important that they support the development of their students' critical literacy of these modes through critical inquiry.

3.11. Critical Literacy and Critical Graphicacy

Though literacy, numeracy and articulacy are familiar constructs in education, Tan et al. (2020) claim that we should "broaden the notion of literacy beyond the linguistic mode" (p.110). Eutsler (2021) argues for the inclusion of visual literacy in teacher education, while Lacković (2020) reflects on the need to apply critical graphicacy (Roth et al., 2005). Building on Balchin's (1972) concept of graphicacy, Danos and Norman (2011, p. 103) consider graphicacy as "the ability to communicate using still visual images, such as graphs, maps, drawings etc. drawings, etc." Critical graphicacy encourages us to interrogate the visual representations of the world, and to identify "the intent and the intentionality" (Lacković, 2020, p. 109). The need for this critical inquiry of photographs was argued by Goldstein (2007) who contested that all photos lie, and that the viewer should question the extent to which deviation from reality is acceptable to them to answer the question they ask. Kress & van Leeuwen (2006) also make this point and discuss the questions of truth and reality as they are represented in different modes, noting that we trust some modes more than others, in particular the visual mode. However, we know now that digital technologies allow for substantial modifications of visual representations, as exemplified in the Instagram vs Reality dichotomy discussed by Tiggemann & Anderberg (2020). Kellner & Share (2005) propose that teaching critical media literacy can encourage "students to learn from media, to resist media manipulation, and to use media materials in constructive ways […]" (p.372).

While critical media literacy is extended to all modes, critical graphicacy encourages

students to move beyond considering images as “exposition tools” (Lacković, 2020, p. 88) used to illustrate a point. Instead, they are invited to examine the image more closely, asking questions to enhance their understanding of the associated concept. Hallewell & Lacković (2017) call for the adoption of critical graphicacy within the traditional setting of the higher education lecture. Their analysis of 22 lectures across 16 universities in the UK revealed that only 9.7% (n=14) of the 145 photographs used in the slides invited students to interrogate the photographs either partially or as a whole. In a world of hyper-visuality (Lacković, 2020, p. 443) critical inquiry is promoted to explore the how these signs operate in a particular historical or social context. In addition, it is needed to foster students’ critical engagement “by exploring the three places of meaning-making: production, consumption and the photograph itself” (Rose, 2012, as cited in Lacković, 2020, p.1175).

This section discusses the place of multimodality in higher education teaching and learning, concluding that there is a need for critical engagement with the signs represented within the digital resources. The multimodal inquiry framework developed as part of this research study is presented below as a guided and critical inquiry approach when teaching disciplinary concepts.

3.12. A Multimodal Inquiry Framework

The following proposed multimodal inquiry framework adapts the Multiliteracies model developed by the New London Group (1996) (Figure 6) and builds on an inquiry graphics analytical framework (Lacković, 2020) introduced earlier. It will be used to interrogate the multimodal composition of the screencast. Cazden et al. (1996) explore the design elements of different modes of meaning with a view to developing a literacy pedagogy, which would supplement curriculum and pedagogical approaches to teaching English. I argue that we can adapt this model to include an inquiry focus, which explores and reveals the semiotic choices of the designer of the screencast and promotes a pluralistic approach to the teaching of disciplinary concepts.

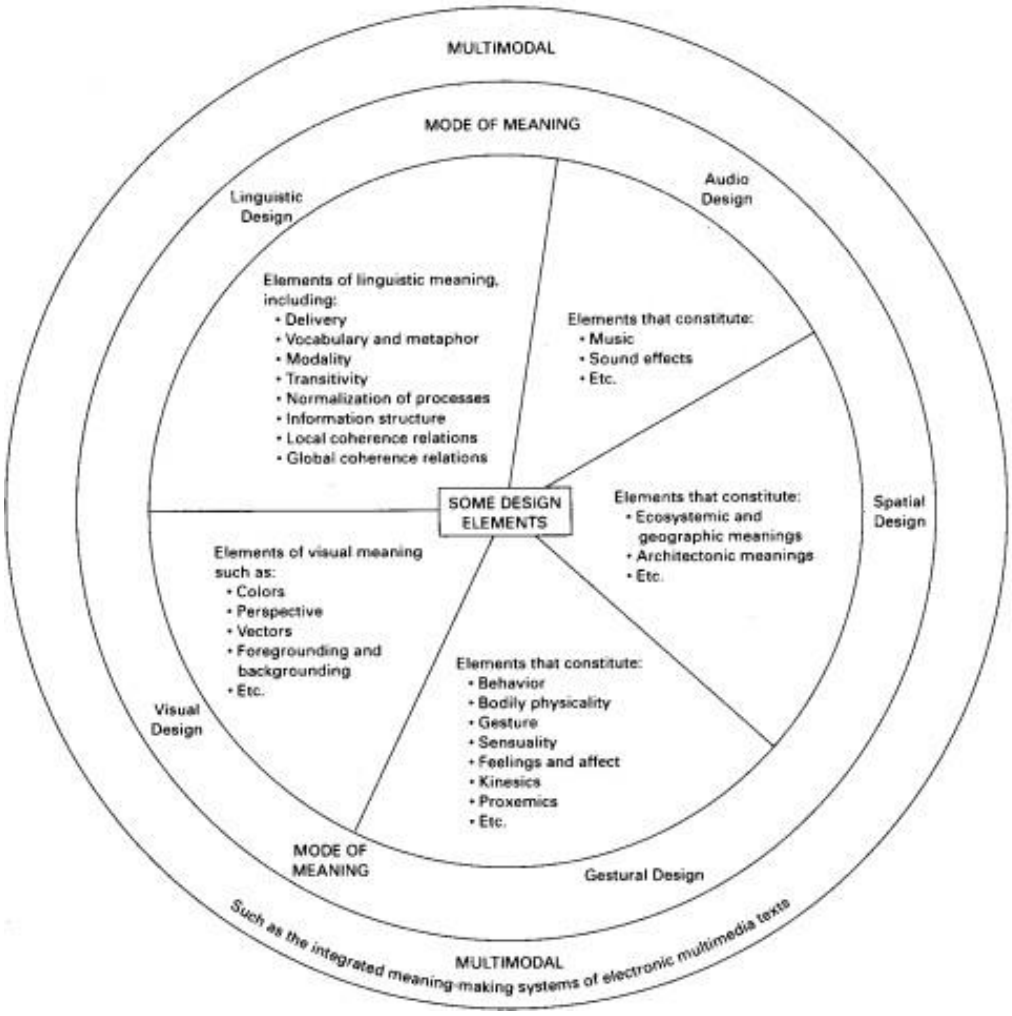


Figure 6: Multiliteracies: Metalanguages to Describe and Interpret the Design Elements of Different Modes of Meaning (New London Group, 1996, p. 83)

The way in which the multimodal inquiry framework was applied within this research study will be explored in Chapter 4.

Since the aim of the research was to explore the semiotic choices of lecturers in the design of the screencast used to teach a concept within their discipline, I wanted to 'inquire' the screencast. This entailed consideration of each of the modes individually, in terms of their meaning-making potential, but also consideration of the screencast as a 'whole', a multimodal ensemble (Jewitt, 2013, p. 250) where the combination of modes produced a semiotic resource which reflected the lecturer's understanding of how the concept should be taught.

3.12.1. Layer 1. The Multimodal Ensemble: affordances of individual modes.

A workshop on Inquiry Graphics (Lacković, 2020) demonstrated how this approach could be used to analyse multimodality (e.g., both the visual and linguistic modes) within educational resources, since the Inquiry Graphics sign comprises all graphics, i.e., 'anything that leaves a trace on a surface" (Lacković, 2020, p. 418) therefore including images and text. While the published research on Inquiry Graphics focuses primarily on digital photographs, Lacković argues that it could equally apply to other visual elements "static/still (e.g., a non-animated drawing, photographs, written words, collage, murals and animated (a video, an animation, any graphics in motion" (ibid)) and other modes. I adopt this expansion of the Inquiry Graphics sign into a multimodal sign, and inquiry graphics into multimodal inquiry, where the Representamen include all the different modalities that form the multimodal ensemble of the screencast. The inquiry is the Interpretant across transmodality and transduction, i.e., the interpretation and intention of lecturers, while the Object relates to knowledge, or the concept being presented. This multimodal inquiry (MMI) adaptation of Inquiry Graphics (IG) can be summarised as:

- **Representamen**: All the different modalities that form the multimodal ensemble of the screencast.
- **Interpretant**: How lecturers (in this case, but it could be anyone, e.g., learners) interpret the screencast multimodal semiotic resources and their use.
- **Inquiry Object**: How the different modalities that form the multimodal ensemble of the screencast relate to taught concepts and learning objectives and how they are brought together.

With regards to different modes, Culache (2015) provides a useful table on the sensory dimension of modalities within multimodal messages, which include several modalities present in the screencast and which I adapt below.

Table 3:3: The sensory dimension of modalities adapted from Culache (2015, p. 499)

Modalities	**Representative sensory dimension**
Colours	Visual
Layout	Visual
Soundtrack	Auditory
Writing	Visual, Linguistic
Images	Visual
Music	Auditory
Voice	Auditory

This table identified the most salient modalities within a screencast and prompted the addition of both auditory and layout modes to the Inquiry Graphics sign. The following section will provide the rationale for including both within the multimodal inquiry framework and choosing what to call them.

Audio is an integral part of the screencasts analysed and consists of some combination of lecturer narration, external narration (where external videos were included) and music, though not all screencasts used all these modes). Examples are given in the literature of the benefit of audio for feedback (O'Regan et al., 2016; Rotheram, 2009b, 2009a); how music can activate an emotional response to a scenario (Juslin & Västfjäll, 2008; Scherer & Zentner, 2001) or how the voice can embody a relational pedagogy (Adams, 2018). Studies have also researched the importance of the voice as a teaching tool (Hämäläinen et al., 2018; Servilha & Costa, 2015), however, only a limited number of studies consider the combination of voice and other modes as "semiotic companions" (Tyrer, 2021). The inclusion of audio within the framework allowed me to explore the semiotic use of speech and music to teach a concept. I chose to use the term audio, rather than auditory, since this is the term most commonly used in the literature to describe this mode.

In response to the literature about the affordances (Conole & Dyke, 2004) and the sociomaterial nature of digital technologies (Gourlay & Oliver, 2018) I decided to include software affordances as a mode. The first iteration of the framework referred to this as the *Spatial Mode*, referencing the spatial decisions made by the lecturer in terms of positioning elements (audio and visual) within the screencast. However, this did not account for the semiotic choices made by the lecturer in terms of the design of the screencast. Neither did it consider the sociomaterial nature of technology and the influence of lecturers' digital fluency and digital literacy. While there are similarities within the screencasts, none of them are identical, which lead to the inclusion of the word Design in the second iteration of the framework, i.e., *Spatial-Design Mode,* influenced by the concept of the lecturer as learning designer (Conole, 2013). Here, the focus is on the design choices the lecturers made in relation to the digital technologies they used for the purpose of teaching. In some instances, this was a combination of Camtasia screencasting software and PowerPoint, in others, lecturers opted to combine Camtasia and a software application, excluding PowerPoint.
Some of the screencasts included external videos, while others embedded animated graphics /simulations. The inclusion of this mode in the framework allowed me to examine these semiotic choices in greater detail and resulted in the four quadrants of the first layer of a multimodal framework.

Once I could identify the salient modalities and consider the potential affordances of each of the modes, I could move to the next level of interrogation of the screencasts in the context of my research questions.

3.12.2. Layer 2. Multimodal Inquiry

Fundamental to Inquiry Graphics is the notion of *inquiry* that stems from Peirce's semiotics,
i.e., a critical reflection on the use of iconic images and a critical image analysis in relation to the concepts it is suggested to represent, moving from the notion of images as "embellishment" to the use of images for serious academic inquiry (Lacković, 2020, p. 366). Video has become a ubiquitous medium, both for educational and entertainment purposes, and the explosion of user-generated content in this space means that anyone can (and does) create videos to communicate a particular message. However, this gives rise to a greater need for critical multimodal literacy, so viewers can consider the semiotic choices of the creator and their associated intentionality. While considerable work has been carried out in the domain of information literacy (e.g., McDermott-Dalton, 2020), the call for the development of

multiliteracies has grown louder. The use of an inquiry approach to digitally mediated resources supports the development of students' critical literacy, through the use of critical media literacy and more specifically critical graphicacy, inviting them to question the semiotic choices of the producer and critically engage with how the medium is used.

Since inquiry is integral to the approach adopted in this study which considers why specific modes or combinations of modes were used to teach a disciplinary concept, the multimodal framework became a multimodal Inquiry Framework, extending the work of Inquiry Graphics to include additional modes of audio and spatial-design. Additionally, a focus on the interactions between and across modes was included, to determine if and how transduction/ transmediation occurred. This also allowed me to inquire how knowledge was 'translated' or reshaped (Jewitt, 2003b) across modes, and whether particular modes were foregrounded or backgrounded, because of a perceived importance within the relevant discipline. Which modes are the main carriers of meaning? Is there evidence that socially situated practices influenced the choice of modes? These questions guided the inquiry at this stage of the process.

The analysis of video (Jewitt, 2012a; Lacković, 2018) presents researchers with significant challenges in terms of the amount of data produced, leading to "overwhelming amounts of rich video data" (Jewitt, 2012, p. 18). I made the decision to focus on the specific key moments identified by the lecturers, since they were chosen as key moments for learning within the screencast. The benefits were two-fold; firstly, these key moments were chosen by participants as being of specific importance to students' understanding of the concepts and were not researcher-led, providing an authentic, valid selection process; secondly it was a manageable quantity for in-depth analysis. In addition to the analysis of these key moments I intended to provide a holistic analysis of the screencast (Zoom Out), to discover the meaning-making potential of the screencast as a whole, building on Lacković's (2020) "image- concept-inquiry" (p.183) to move to screencast-concept-inquiry.

3.12.3. Layer 3. Teaching and Learning for Knowledge Development

The final layer of analysis relates to the final research sub question and the use of screencasts within an educational context, i.e., to develop students' disciplinary knowledge and/or skills. Participants for this research study were purposefully selected because they had completed a professional development module on Technology Enhanced Learning (TEL) and created the screencasts as part of the module

assessment. The third research question seeks to understand how the sociocultural practices of the lecturer and their situated context influenced the design and creation of teaching resources, in particular the multimodal screencast.

A challenge for those involved in faculty professional development (both facilitators and practitioners) is the translation of theory into practice. Within the TEL programme, the screencast embodied this process, and I hoped that examination of lecturers' pedagogical approaches could provide valuable insights into their epistemological perspectives about how knowledge is created and best represented within their discipline. Through developing an understanding of the sociocultural practices that underpin their teaching approaches, I sought to understand better their beliefs about how concepts should be taught and how these were embodied within the screencast. Evidence of these practices could be visible in the design of the screencast and may also be revealed through discussion with the lecturers during the qualitative interviews, leading to an acknowledgement of the socially situated nature of teaching and a better understanding of the multimodal semiotic resource that is the screencast.

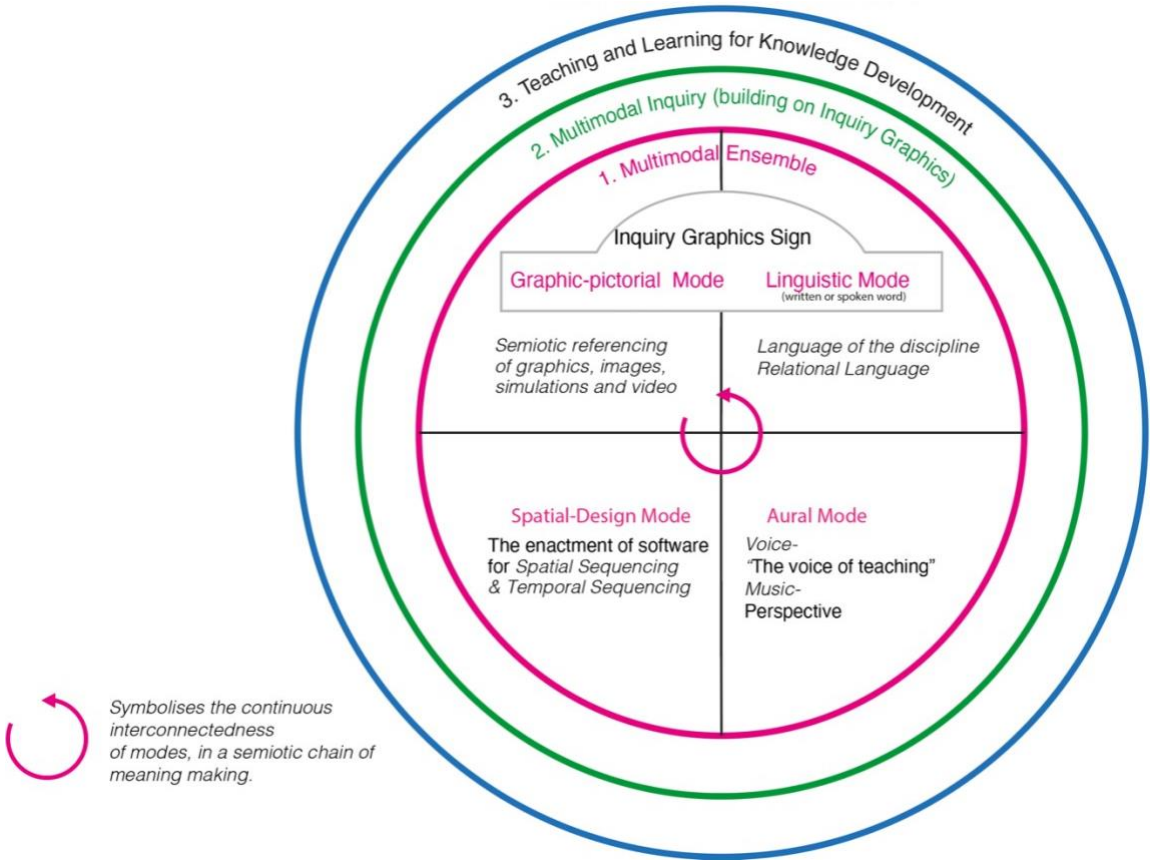


Figure 3:3: A multimodal inquiry framework

The pink and green layers characterise the Representamen-Interpretant, or how the modes present in the screencast are interpreted for teaching and learning. The outer blue layer represents the Object or educational goal, i.e., the objective assigned to the multimodal format of the media, with its multimodal affordances and interpretations. Adapting the IG triadic model proposed by Lacković (2020, p. 67), the model proposed below (Figure 8) represents the MMI Framework as it relates to Peirce's triadic sign. It exchanges the visual Representamen (R) with a multimodal ensemble and its affordances, while interpretation (I) focuses on cross-modality, transmediation and transduction. The final conceptual Object (O) is the purpose of the modal inquiry, i.e., students' knowledge development.

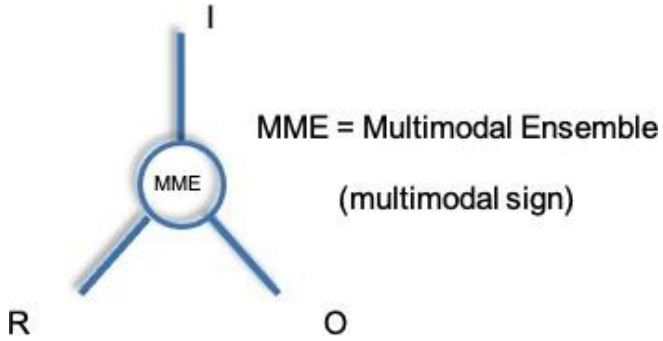


Figure 3:4: A multimodal sign, adapted from Lacković (2020, p.67)

3.13. Conclusion

This chapter outlines the iterative development process of a new multimodal inquiry framework, for the analysis of multimodal screencasts. It follows a discussion on multimodality in higher education, within the context of professional development of teaching faculty, which considers the affordances of digital technologies for meaning making within the socially situated practice of teaching.

Chapter 4 will detail the methodological approach to this research study, in particular the Inquiry Graphics approach which informed the design of the multimodal inquiry framework above.

Chapter 4: Methodology

This chapter provides an overview of the research design for the present study. The research questions and research design are included initially, and a rationale for the choice of research design supported by relevant educational research literature is presented.

Following this, details of the implementation of the chosen research design and related issues are presented. An ontological and epistemological perspective are offered as they relate to the present study and ethical issues and considerations of trustworthiness are discussed, as they pertain to a qualitative research approach. Finally, with the limitations of the study in mind, I offer modest suggestions about the potential for this research to contribute to the literature on multimodality and lecturers' meaning-making practices in Higher Education.

4.1. Research Questions

The aim of this research study is to examine the following to form an **overarching research question:**

What multimodal affordances are selected and applied by university educators in digital multimodal screencasts to teach key concepts within their specific disciplines and how are these applied?

This approach is informed by the arguments that teaching, learning and knowledge development are multimodal, as discussed in the literature review. The above research aim is further divided into specific research questions:

- How can the use of a multimodal inquiry (MMI) framework, developed by the thesis researcher, that builds on an Inquiry Graphics approach, support the teaching of key disciplinary concepts? This question includes the following subquestions:
  - How are key disciplinary concepts articulated through the multimodal ensemble of the screencast?
  - How are conceptual ideas and screencast elements brought together?
- How is the multimodality of the screencast related to the sociocultural practices of the lecturer and their situated context?
- What are the implications of the findings for an understanding of online and screencast-based teaching as a relationship between knowledge and its multimodal elements and affordances enacted through digital technologies– how do the two relate and what does it mean for teaching practice?

4.2. Research Design

This research adopts a qualitative inquiry approach, since the aim was to acquire a deeper understanding of how lecturers crafted multimodal screencasts to teach a disciplinary concept. Creswell (2013, p. 44) notes that qualitative research "begins with assumptions and the use of interpretive/theoretical frameworks that inform the study of research problems addressing the meaning individuals or groups ascribe to a social or human problem". A qualitative research approach allows participants to tell their stories, to provide an insight into their experience of the phenomenon in question. Here, it allowed me to explore the mechanisms and structures that influenced how lecturers approached the design of the screencasts, and their meaning-making practices.

The following table outlines the research design adopted for this thesis, as it relates to the research questions above.

Table 4:1: Research Design

Ontology & Epistemology	***Peircean Pragmatism*** *~A basic realism about the world* *~Knowledge is fallible and is derived from our encounters with reality and our experiences of the world.*	
Theoretical Framework	***Edusemiotics & Multimodality*** *~The study of multimodal signs (such as screencast) in the context of education.*	
Methodology	***Case Study: in One Institution***	
Method	**Data Collection**	**Data Analysis**
RQ1 **How can the use of a multimodal inquiry (MMI) framework, developed by the thesis researcher, that builds on an Inquiry Graphics approach,**	Multimodal Screencasts & Interview Data	Multimodal Inquiry (MMI) Framework

support the teaching of key disciplinary concepts?		
RQ1 (subquestions) **How are key disciplinary concepts articulated through the multimodal ensemble of the screencast? How are conceptual ideas and screencast elements brought together?**	Multimodal Screencasts	Multimodal Inquiry (MMI) Framework
RQ3 **How is the multimodality of the screencast related to the socio-cultural practices of the lecturer and their situated context?**	Interview Data	Multimodal Inquiry (MMI) Framework & Qualitative Data Analysis
RQ4 **What are the implications of the findings for an understanding of online and screencast-based teaching as a relationship between knowledge and its multimodal elements and affordances enacted through digital technologies– how do the two relate and what does that mean for teaching practice?**	Multimodal Screencasts & Interview Data	Multimodal Inquiry Framework (MMI) & Qualitative Data Analysis

4.3. Ontology and Epistemology

The ontological perspective adopted in this thesis is grounded in semiotic pragmatism, as envisioned by Charles Sanders Peirce. Peircean pragmatism has at its heart a basic realism about ontology and an inquiry into the nature of reality, noting “there are real things, whose characters are entirely independent of our opinions about them” (*Writings of Charles Sanders Peirce*, p.254, as cited in Lane, 2018, p. 29). However, Peirce argued that we could arrive at a more complete understanding of concepts using scientific inquiry, which is “essentially a communal endeavor” (Colapietro, 2006, p. 14). Doubt is the starting point of our questioning and the inquiry process, and through a process of abduction (or hypothesising about what might be happening),

deduction and induction using the scientific method, Peirce contended that we could arrive at a resolution which would dispel the doubt and “which is a form of stability and satisfaction” (Rosenthal & Thayer, 2022), whether we are considering physical or abstract concepts. However, he also asserts that our beliefs are fallible and as such, even though we may believe a proposition, it is not enough to establish its truth (Ayer, 1968). Evolutionism (Burch, 2022) and the fallibility of our knowledge pushes us to continue this inquiry according to Peirce, who rooted his analysis of doubt and inquiry within a theory of signs, where “communication, thought, knowledge, and intelligent conduct could be fully understood” (Rosenthal & Thayer, 2022). Knowledge is linked to experience, and “there is no knowledge antecedently acquired in the light of which experience is to be interpreted. The interpretation itself is experience” (CP 7.527, as cited in Olteanu, 2015, p. 258). Peirce understood that knowledge was derived from our encounters with reality (Colapietro, 2006) and our experiences of the world, an epistemological viewpoint I share, and which extends to the theoretical approach adopted in this thesis, as outlined in Chapter 3.

4.4. Methodology

The following section provides a rationale for the choice of case study methodology. It also includes a discussion on alternative methodologies, considered but subsequently disregarded for this research study.

Case study research attempts to answer the how and why questions associated with a contemporary phenomenon, “where the boundaries between phenomenon and context may not be clearly evident” (Yin, 2018, p. 15). Given that this thesis aims to explore the way in which lecturers composed their screencasts (“how”) and to investigate their choice of modes (“why”), a case study approach was considered appropriate. Adopting an embedded case study design (Yin, 2006), this research focuses on a group of academics across a range of disciplines within one higher education institute in Ireland, to discover how and why they chose particular modes in the creation of a screencast to develop students’ knowledge within the discipline. Within unit (screencast) analysis will examine individual lecturer’s choice of modes, while cross unit analysis will attempt to identify similarities or differences between the cases (Yin, 2018).

4.5. Alternative methodological approaches

Alternative research approaches considered to answer the research questions included phenomenology, an approach that would provide interesting first-person accounts of the lived experience of lecturers (Groenewald, 2004) who created the screencasts.

However, my interest lies in examining how lecturers designed the screencasts, why they chose specific modes and how they felt this might help develop students' knowledge of disciplinary concepts, all of which point to choosing a case study approach.

Phenomenography was also explored. Earlier research within the PhD programme (McDermott-Dalton, 2020b) provided an opportunity to use this methodological approach in the study of students' experiences of personalised filters. Phenomenography focuses on the qualitatively different ways in which a phenomenon is experienced (Marton, 1986) and attempts to categorise the variation in experiences into an "outcome space" (Trigwell, 2006, p. 370). Since this approach would primarily be concerned with the collective experience of lecturers creating a screencast, it would not provide scope for investigating the screencast itself (the phenomenon), which was the intended focus of this thesis.

The third and final approach considered was Cultural Historical Activity Theory (CHAT) (Engeström, 1987), which has been used successfully in multimodal studies (Godhe & Magnusson, 2017; Jewitt, 2008; Ma, 2014) and which I used previously within the PhD programme (McDermott-Dalton, 2021). As an attempt to understand an activity (e.g., the creation of a screencast) in the context of a collective (Bligh & Flood, 2017), Activity Theory does not consider "what is going on inside the individual" but instead focuses on what "happens between human beings, their objects, and their instruments when they pursue and change their purposeful collective activities" (Sannino & Engeström, 2018, p. 44). For this thesis, Activity Theory could examine the subject-object interaction, i.e., the creation of the screencast from the viewpoint of the lecturer, considering the subject's position in the social world (Kaptelinin & Nardi, 2006). Contradictions within and between elements of the activity system would also be highlighted given Activity Theory's dialectical stance. While this would produce an interesting study, it does not address the research questions of this thesis, which focus on the creation of screencasts for teaching disciplinary concepts.

4.6. Methods

This section presents the research methods used within this qualitative research study. The selection and recruitment of participants is outlined initially, followed by a discussion on the data collected and the method of analysis used.

4.6.1. Participants

Purposive sampling as a technique is used in many cases "to access 'knowledgeable people'" (Cohen et al., 2007a, p. 115), i.e., people who have an in-depth knowledge about a particular event or issue. Though many HE lecturers use screencasts in their teaching, I decided to focus on a particular cohort who had completed an accredited module, for which the development of screencasts was an integral part of the curriculum and assessment. Firstly, this provided a bounded case, which helped determine the scope of data collection for the purpose of this study (Yin, 2018). Secondly, I was familiar with participants' general level of knowledge in the context of educational theories, multimedia design principles and universal design principles, since I was one of the TEL module facilitators and had worked with the participants throughout the module. This was important as I knew they could speak knowledgeably about the issue (Cohen et al., 2007a), i.e., they could articulate their ideas based on their knowledge of educational theories and concepts (formative assessment tasks throughout the module required participants to articulate their pedagogical approaches, so they already had experience of this). Given that this research focuses on the use of screencasts for *teaching* disciplinary concepts, it was important that participants could link their screencast design to their choice of pedagogical approaches.

The TEL module accepts a maximum of 12 participants for each annual intake, but I decided to focus on recruiting participants who had completed TEL within the three years from 2015- 2018. This was to ensure that the screencasts were still relevant to the lecturers' teaching practice at the time of data collection (Programmatic Review happens every 7 years within the research institution and modules may change focus significantly during that process, potentially rendering some resources obsolete).

The initial aim was to recruit participants from a potential cohort of 36 lecturers. Collective case study research aims to identify a representative sample, "to maximise what we can learn" (Stake, 1995, p. 4). From the potential group of participants, 16 lecturers agreed to take part in the research. While the number of participants may not be considered sufficient to represent the wider community of lecturers in Higher Education, I argue that given the range of disciplines represented in the study, the

significant amount of data generated, and the extensiveness of the analytical process in relation to the screencasts (Jewitt, 2012), there is less need for an extensive list of participants. The table below provides information relating to the range of disciplines and the teaching experience of lecturers. Randomized pseudonyms were assigned to protect the anonymity of participants.

Table 4:2: Research Participants

Participant Name	Discipline	Number of years teaching	Professional Development Pathway of Lecturers	Student groups involved
Robert	Business Computing	4 years	Postgraduate Diploma in Learning, Teaching & Assessment	Part-time students
Frank	Design	9 months	Certificate in Learning & Teaching, Certificate in Technology Enhanced Learning	1st year- 4th year
James	Engineering	7 years	Postgraduate Diploma in Learning, Teaching & Assessment	1st years mainly
Sophie	Social Sciences	4 years	Postgraduate Diploma in Learning, Teaching & Assessment	1st year- 4th year
Fiona	Academic Student Services Support	8 years	Postgraduate Diploma in Learning, Teaching & Assessment	All students
Martina	Academic Student Services Support	19 years	Certificate in Technology Enhanced Learning, Certificate in Developing	All students

			Online Practice in Learning, Teaching & Assessment, Certificate in Mentoring	
Saran	Hospitality, Tourism and Leisure	27 years	Postgraduate Diploma in Learning, Teaching & Assessment	All years
Brenda	Engineering	2 years	Postgraduate Diploma in Learning, Teaching & Assessment	Apprentices
Aoife	Life Sciences	4 years	Postgraduate Diploma in Learning, Teaching & Assessment	2nd/3rd/4th years
Patrick	Hospitality, Tourism and Leisure	6 years	Postgraduate Diploma in Learning, Teaching & Assessment	Apprentices
Conor	Engineering	14 years	Certificate in Technology Enhanced Learning, Certificate in Developing Online Practice in Learning, Teaching & Assessment, Certificate in Learning & Teaching	4th and 5th years
Paul	Business	7 years	Certificate in Technology Enhanced Learning, Certificate in Developing Online Practice in Learning, Teaching & Assessment, Certificate in Formative Assessment & Feedback	Adult Education groups
Joseph	Life Sciences	6 years	Certificate in Technology Enhanced Learning,	1st and 2nd years

			Certificate in Learning & Teaching	
Sandra	Engineering	4 years	Postgraduate Diploma in Learning, Teaching & Assessment	1st years mainly
Joanne	Health Sciences	10 years	Postgraduate Diploma in Learning, Teaching & Assessment	1st and 2nd years
Keith	Health Sciences	6 years	Postgraduate Diploma in Learning, Teaching & Assessment	All years

Following the guiding principles proposed by Yin (2018), data was collected in the form of the screencasts created by lecturers and qualitative interviews conducted with research participants, using video elicitation. In each of the following sections the data collected is initially presented and followed with the chosen analytical approach.

4.7. Data Collection I: Multimodal Screencasts

Lecturers who completed the Certificate in Technology Enhanced Learning (TEL) created the screencasts with Camtasia (or Screencastomatic if the participant did not have access to Camtasia) and saved the video as an mp4 file, as per the criteria outlined in the assessment rubric (see Appendix 1). They were required to upload the completed screencasts to the Institute Virtual Learning Environment (VLE) and to YouTube as part of the module's assessment strategy. Since these screencasts were archived within the institutional VLE, access to the screencast was initially unproblematic once consent was given. However, during the data collection phase it transpired that the 2016 archived VLE was no longer available, so participants were asked to share the YouTube link (or mp4 file) directly. This impacted nine participants, but all were able to recover their files and share them. All mp4 video files were stored in a secure cloud location (Microsoft Office 365 OneDrive) using pseudonyms to protect the anonymity of participants.

Although all screencasts were included in the initial analysis, I decided to focus on three screencasts for a subsequent in-depth analysis. These were chosen following careful

consideration of several criteria as outlined below. Though some screencasts within the dataset may have provided richer data for a multimodal analysis than those chosen here, I was concerned that using these risked identifying the lecturer, either because of the small number of academic staff teaching within that discipline area or because of the specificity of the topic. As a result, several screencasts were discounted from the dataset for detailed analysis.

Secondly, once participant anonymity could be ensured, I opted to choose screencasts which used a variety of modes, to increase the representative value. At the initial stage of analysis, the semiotic weighting of modes was considered for each screencast to determine if major/minor carriers of meaning were evident. This assumption was supported by evidence within the qualitative interviews with participants. A simple graphic such as the one below provides a visual representation of the weighting of modes within the screencasts.

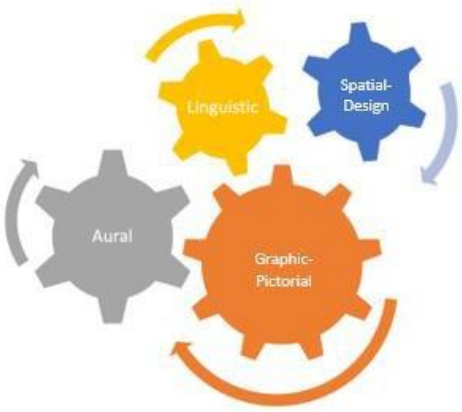


Figure 4:1: Semiotic weighting of modes within the screencast identifying which modes were most prominent.

Finally, in addition to choosing screencasts for analysis on the merit of their semiotic weighting of modes, I also opted to also consider their representative value across academic disciplines. The three chosen screencasts are created by lecturers within three Faculties of the HE institution. Both early career and more experienced lecturers are included, as is a varied target audience, outlined in the table below.

Table 4:3: Breakdown of chosen screencast sample

	Discipline	Target Audience	No. of Years Teaching
Screencast #1	Business & Hospitality	First Year	7
Screencast #2	Life Sciences	Fourth Year	4
Screencast #3	Health Sciences	Second Year	10

4.8. Data Analysis I: Multimodal Screencasts using a Multimodal Inquiry Framework

The multimodal inquiry framework (MMI) which was developed as part of this research study was used to analyse the screencasts. I imported all screencasts into Nvivo 12™ and used an abductive approach to data analysis, moving between the theory and the data. I include the MMI framework here and reiterate the layered approach to inquiry which was part of the analytical process.

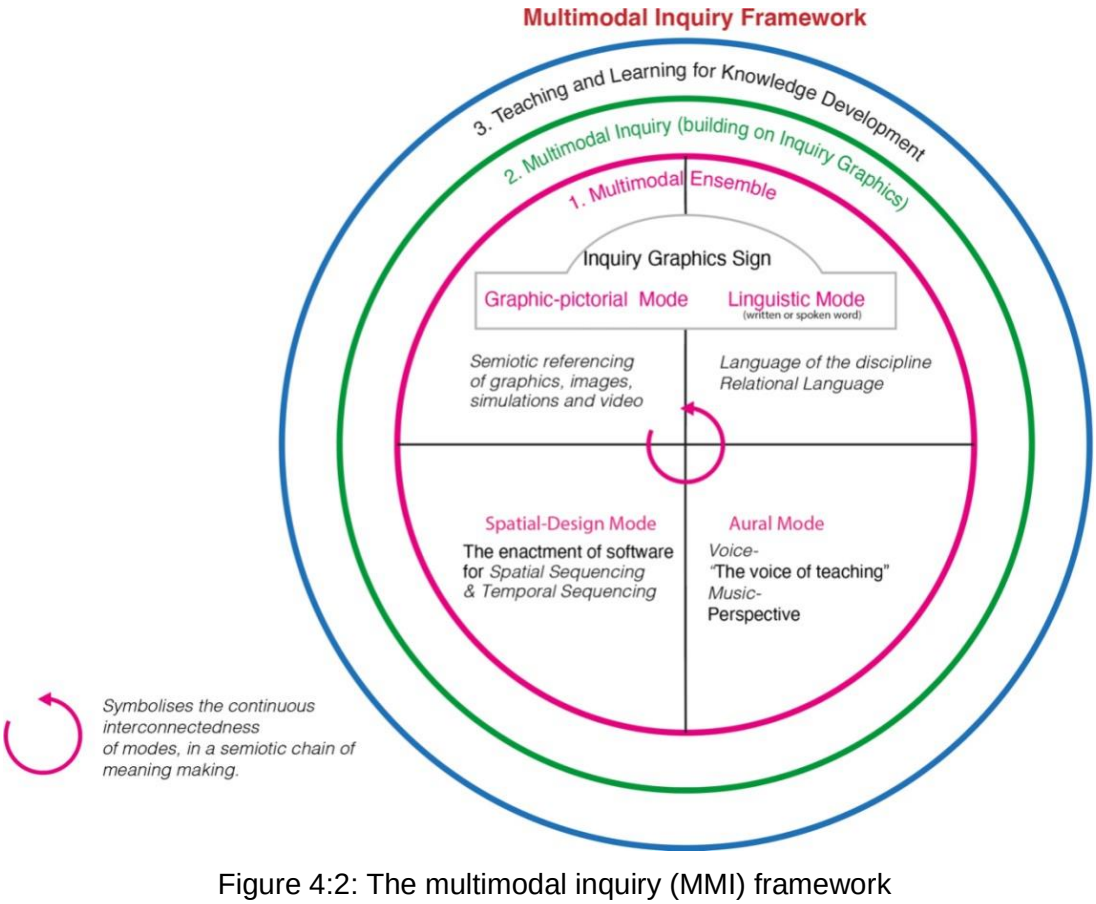


Figure 4:2: The multimodal inquiry (MMI) framework

All 16 screencasts were viewed several times initially to get a sense of the whole (Cohen et al., 2007a) and to become familiar with the semiotic modes present. This helped refine the MMI framework presented in Chapter 3.

Using timestamps to indicate coding location, Phase 1 captured general information relating to the screencasts such as the type (lecture or software demonstration) and length of the screencasts, number of modes present, inclusion of external resources (e.g., videos, animated graphics/simulations) and software used (e.g., PowerPoint, discipline-specific software applications, etc.).

Once I had captured key information relating to the different modes included in the MMI Framework, I began Phase 2 of the analysis which focused on the coding elements within each mode, across the dataset of screencasts. These included (but were not limited to) graphic-pictorial elements, external videos, and animated graphics; instances of disciplinary language and literacy, or relational language; examples of the use of voice as the embodiment of a lecturer's instructive mode and finally, evidence of the enactment of software features. For this phase, the 16 screencasts were analysed iteratively several times. In the first iteration the focus was on Layer 1 (the multimodal ensemble) and each screencast was analysed a minimum of four times with a specific analytical lens on one of the four quadrants (modes) at each viewing. Graphic-pictorial elements were categorised in terms of their semiotic referencing concerning lecture content and lecture topic (Hallewell & Lacković, 2017), as outlined in the table below. It is worth noting here that types in taxonomies can often create too fixed a description. Also, while the descriptors in this taxonomy were defined according to one significant or salient use, they could include other descriptors, e.g., interrogation could include articulation. To remind the reader, the types of graphics (e.g., photographs, drawings) are presented in the table below, noting that semiotic articulation, interrogation invitation, and critical semiotic exploration are not mutually exclusive, as it is the case between these three types and unprobed representation, where the graphic is simply not mentioned.

Table 4:4: Semiotic Referencing (Hallewell & Lacković, 2017)

Taxonomy	Subcategory	Descriptor
Unprobed Representation	Attentional	The graphic (e.g., illustration or photograph) is not *mentioned* in the lecturer's narration of the slide.
	Depictional	The graphic features in the lecturer's narrative but is not directly referred to.
Semiotic Articulation		The lecturer's narrative references the graphic or elements within the graphic as they relate to the concept.
Semiotic Interrogation Invitation		The lecturer invites the viewer (student) to interrogate the graphic or some of its elements and related meaning.
Critical Semiotic Exploration		The graphic is analysed (critically) by the lecturer.

Following this, the focus shifted to Layer 2 (multimodal inquiry), where initially all 16 screencasts were analysed to uncover instances of transmediation/ transduction. Multimodal Discourse Analysis (MMDA) extends the analysis beyond language to focus on how meaning is made using multiple modes (Jones, 2012) and thus informs this study, since it provides an additional layer to explain the intersemiotic relations that occur between modes (Jewitt, 2013b) Additionally, the concept of resemioticisation, introduced by Iedema (2003), considers "how meaning making shifts from context to context, from practice to practice, or from one stage of a practice to the next" (p. 41). From the perspective of developing students' knowledge within the disciplines, it is interesting to examine how resemioticisation may occur as lecturers draw on their own knowledge and teaching experience to select modes for the screencast.

Kress (2011) considers the processes of design, composition, and production of semiotic work of "textual threads" (p.36), such as gesture, image, speech, writing and highlights the coherence of these texts, "realized by semiotic means" (ibid), as socially made and dependent on the community in which they are used. MMDA, he argues,

aims to “provide insight into the relation of the meanings of a community and its semiotic manifestations” (ibid, p.37). For this study, this approach complements the Element Connotation analysis of the IG model, which considers environmental and sociocultural contexts of elements listed. Here, additional care was given to ensure the validity of any claims made, returning to interview data regularly to ensure that the evidence supported the claims (Yin, 2018).

The final stage in this phase of the analysis focused on Layer 3 (teaching and learning for knowledge development). Examples of teaching and learning approaches, exemplified in the screencast (e.g., instructional scaffolding, UDL) were coded and “units of relevant meaning” (Cohen et al., 2007a, p. 370) were clustered as they related to Layer 3.

The rationale for including an overarching analysis of all 16 screencasts, with examples from across the dataset, was to provide additional evidence in support of the claims made within the thesis.

During Phase 3 of the analysis, the multimodal analytical framework was applied to three of the 16 screencasts. The process outlined in Phase 2 was repeated with a more in-depth analytical lens focusing on Key Moments within the screencasts, as identified by the lecturers. However, in Phase 3 the MMI Framework was used to move beyond thick description to *abduction*, an additional mode of inference (Deely & Semetsky, 2017b) through theoretical engagement with the data. A zoom-in / zoom-out approach was used for analysis, initially focusing on the Key Moments, subsequently followed by a more holistic analysis of the entire screencast using the additional Composition Denotation (CD) and Connotation (CC) stages of the Inquiry Graphics framework to consider the screencast in the context of developing students’ disciplinary knowledge.

4.9. Data Collection II: Qualitative interviews

Relevant lecturers were invited by email to take part in the study and were asked to indicate their willingness to participate by return. Following this, a participant information sheet, participant consent form and invitation to interview were emailed to those who had replied (Appendix 2). Semi-structured interviews took place within a two-week period in June 2019. Two participants were unable to attend the original scheduled interview, which resulted in interviews being rescheduled during September and October 2019 (once lecturers returned from summer break). Thirteen interviews were conducted on site within the researcher’s institution, as this was most convenient for the lecturers involved. Three interviews were conducted via Skype at the request of

the participants. All on-site interviews were recorded using the inbuilt iPhone voice recorder app and saved to a secure cloud location (Research Institute Microsoft OneDrive account). All Skype interviews were recorded using Skype's inbuilt recording functionality and subsequently saved to OneDrive, as before.

Interviews were transcribed using https://otter.ai as a transcription tool. The transcriptions also included information about participant reactions within the interview, such as facial expression, gestures, etc. Cohen, Manion, & Morrison (2007a) argue that transcriptions often do not tell the whole story of an interview, so every effort was made to note participants' reactions, where these were directly relevant to the questions asked in the interview or the analysis of the screencast.

Jewitt (2012, p. 4) describes the practice of video elicitation in research as useful "to gain insights on a point of view or to learn more about the meaning of practices and structures of knowledge". Research from Douglas et al. (2015) on the use of artefacts' elicitation as a method of inquiry helped structure interviews with participants. The screencast acted as a prompt to jog participants' memories and to elicit potentially rich descriptions about the choices made. Prior to the interview participants were invited to watch the screencast with the following questions in mind:

- You have chosen to create a screencast to help teach a particular concept within your discipline. Could you identify key /critical moments for learning within the screencast?
- Reflect on the use of text, images, and voice in the screencast as they are used to teach the concept. Which do you use more of? How does each of these help to explain the concept?

The semi-structured interviews lasted between 45 minutes and one hour and were organised as follows:

Part 1: Participant Information

Meaning-making practices are socially situated (Jewitt et al., 2016) and an understanding of context is integral to understanding these practices. The first part of the interview asked participants questions about their teaching experience and their use of technology, to establish the extent of their knowledge about the affordances of the different technologies used. The following questions provided prompts for participants:

Table 4:5: Part 1 Interview Questions

Teaching Experience	***What subjects do you teach?***
	How many years have you been teaching in higher education?
	How many Learning & Teaching modules have you completed?
Use of Technology	*Was this your first time to create a screencast?*
	Can you remember how you found this? i.e., difficult / easy?
	Can you remember how you went about creating the screencast?

Part 2: Knowledge Development

Following this, participants were invited to discuss the concept they chose to present in the screencast, situating it in the context of the module, programme, and knowledge within the discipline. They were asked to consider if the concept was a threshold concept or alternatively a core concept (Meyer & Land, 2010). The rationale for this was to determine whether participants felt that a multimodal semiotic resource, such as a screencast, could be used to teach key concepts within an academic discipline.

Table 4:6: Semi-structured interview questions relating to knowledge development

Situating the screencast	***Why did you choose this topic for the screencast?***
	Can you tell me a little about the module you intended to use this screencast for?
	Is this assessed? Can you tell me a bit about the assessment?
A threshold or core concept	*Does the concept being explained constitute a threshold concept within the discipline?*
	Is this concept accepted within the wider discipline as something students need to have? E.g., a way of thinking like an Engineer, Scientist, etc.?

Part 3: The Inquiry Graphics (IG) Framework

The final part of the interview focussed on the use of an Inquiry Graphics (IG) Framework (Lacković, 2020) to analyse together key/ critical moments for learning within the screencast, as chosen by the participants. Although some lecturers chose several Key Moments (KM), only one was selected for analysis within the interview to adhere to the agreed interview schedule. Where possible, the choice of screencast / video frame included all four modes (graphic-pictorial, linguistic, aural and spatial-design) to allow for a richer analysis.

The IG model was used with participants during the qualitative interviews to examine closely their "contextualised semiosis" (Lacković, 2018, p. 7). Lacković (ibid) includes analytical codes for the analysis of video, which were simplified for use with participants during the interview process.

The table below was shared with participants to facilitate the analysis during the interview of their chosen Key Moments for learning within the screencast.

Table 4:7: Inquiry Graphics Framework adapted for this research study

Representamen (E) – Note and list what you see/hear (key words) on the screen	**Interpretant –** **Describe what you see / hear.**		**Object- what does this mean in this research context?**
Time Stamp:	Denotation (D E) -Basic description (Adjectives, looks like, feels like)	Connotation (C E) – What does this mean in the given context?	How does this contribute to the teaching/development of underst anding of the concept? How does the slide and its multimodal elements link to taught concepts, such as food allergies and food intolerances, microbial bioplastics, or Matter?

In the first column participants were asked to list all the Elements they saw on the screen, as nouns in their simplest form *(Representamen).* In some cases, the component parts of an Element were listed, in others it was a composite, e.g., a heading, bullet points, a caption vs text. A basic description of the Elements on the screen followed *(Denotation),* and participants were encouraged to use simple adjectives. The column devoted to Element *Connotation* challenged lecturers to bring the interpretation to the next level. Here contextual or social factors, such as an Element's significance within the discipline, or the participants' experience (teaching or disciplinary) were important. Finally, the interpretation of the Elements within the context of the research being conducted *(Object)* was discussed. Here participants were asked how they felt this resource contributed to the development of students' understanding of the concept in question.

4.10. Data Analysis II: Qualitative interviews

For the analysis of the qualitative interviews, I imported all sources of data into Nvivo™ version 12, i.e., screencasts, interview audio files and interview transcripts, and subsequently adopted an abductive approach, moving iteratively between the theory and the data using the MMI framework.

Participant transcripts were initially coded using the MMI framework. However, this was enhanced through the addition and categorisation of codes as they emerged and related to the three layers of the MMI framework. Constant comparison with relevant literature through an iterative process helped with refining the codes.

Follow up analysis of the interview transcripts considered the action-focus of participants, where noted features such as facial expressions, gestures etc. might provide additional insight into the potential of the semiotic resources used within the screencast, in terms of their ideational, interpersonal, or textual meaning (O'Halloran, 2011).

4.11. Ethical Considerations

Ethics extends to all stages of the research process (Salmons, 2021), from the selection of participants to the objective analysis and reporting of the research. BERA (2011) ethical guidelines for educational research were followed throughout the research process. Ethical approval was granted from the research institute's ethics' committee and from Lancaster University. Participants were informed that consent was voluntary and were provided with an information sheet outlining what the research

entailed, together with a consent form (Appendix 2) which explained in detail the process for which they would provide consent.

Additionally, participants were informed of their right to withdraw from the research, at any time if they so wished. Files were stored in a secure password-protected cloud location, using pseudonyms to protect the anonymity of participants and to ensure confidentiality.

4.12. Insider Research

All participants in this research study are (or were at one point) my colleagues at the research institution. This positions me as an insider researcher, conducting a "study of [my] own social group or society" (Naples, 2003, p. 43, as cited in Greene, 2014, p. 2). Being an insider researcher offered benefits for the purpose of this research study, whether it was identifying potential participants or being "culturally literate" (Trowler, 2016, p. 6) and familiar with institutional context, which is particularly relevant to a study where sociocultural factors are important in determining meaning-making processes. However, there is significant responsibility associated with insider research, both to conduct the research with integrity and to ensure confidentiality and anonymity in relation to the information that colleagues would share with me. The selection of screencasts for in-depth analysis took account of this risk and several screencasts were disregarded because of the potential to identify colleagues, either from the content of the screencast or the responses in relation to their subject area.

4.13. Role Conflict

In addition to the role of insider discussed above, considerations with respect to teacher research applied to this study, since all participants had completed a module, which I co-facilitated. For this reason, it was important to choose participants who had successfully completed the module to help mitigate against potential power implications and interview bias (Trowler, 2016). A relaxed and encouraging approach during the semi- structured interview helped to reduce some participants' self-consciousness, at times when they were asked to explain their rationale for the selection of modes or the composition of the screencast, something they would only have done in an assessment situation with me previously. However, this may have increased the potential for a Hawthorne effect amongst participants, as they "may wish to avoid, impress, direct, deny, or influence the researcher" (Cohen et al., 2007a, p. 189). Nonetheless, once participants were assured of the validity of all answers, it was important to accept their explanations at face value.

I was also cognisant of researcher bias, in particular my own value preferences in relation to the use of different modalities for digital resources (stemming from my experience as a teacher of MFL and in Graphic Design). Norris (1997) challenges researchers to "see what frames [their] interpretations of the world" (p.174) through introspection and analysis. I sought to bracket presuppositions (Tufford & Newman, 2012) about the participants' meaning-making practices and how these were embodied in the digital resources they created, to approach data collection and analysis with an open mind.

4.14. Reliability and Validity or Trustworthiness

Cohen et al. (2007) note that qualitative research is "particularly susceptible to the biases of the researcher" (p.178). Lincoln & Guba (1985) consider that credibility, dependability, and confirmability are more appropriate constructs to determine the trustworthiness of qualitative research, than reliability and validity, constructs often used within quantitative research.

They argue that prolonged engagement, persistent observation, and triangulation are activities that can contribute to establishing the trustworthiness of the research. The use of lecturer screencasts and interviews as two data sources, together with the shared Inquiry Graphics analysis which took place during the qualitative interview allowed me to triangulate the findings and check my understanding of lecturers' perspectives, contributing to the credibility of the research.

This chapter sets out the theoretical foundations on which the present study is based. Adopting a qualitative research design facilitated an in-depth analysis of lecturers' meaning- making practices and how this translated in the design of the screencast. While the study does not seek to be generalisable, I contend that the embedded case study design provides sufficient representation of several academic disciplines to support the argument that the MMI framework can be used to analyse multimodal screencasts for the purpose of answering the specific research questions included above. Chapters 5 and 6 present the findings as they relate to these research questions.

Chapter 5: Findings – Understanding the Multimodal Screencast across the disciplines

The following two chapters (Chapters 5 and 6) present the findings from the analysis of the multimodal screencasts and the qualitative interviews with HE lecturers to answer research questions 1 and 2. Research questions 3 and 4 are explored in the Discussion chapter. In this chapter, an overview of the various disciplines represented, and the combination of modes used in the creation of each screencast will be presented. Following this, I apply the multimodal inquiry framework to the screencasts, to identify the ways in which these multimodal resources were designed to help students develop their knowledge of a disciplinary concept. Examples from the 16 screencasts will be provided to illustrate each of the elements within the multimodal framework. Subsequently in Chapter 6, I drill down into a detailed, thick analysis of three screencasts, focusing on one of the key moments identified by the lecturer-designer and the use of an Inquiry Graphics analysis, to explore lecturers' semiotic design decisions for their multimodal screencasts. These screencasts are also analysed using the developed multimodal inquiry framework (MMI) to reveal further multimodal affordances and explore pedagogical approaches adopted by participants.

5.1. Research Questions

To remind the reader, the main research question which guides this multimodal study is:

What multimodal affordances are selected by university educators in digital multimodal screencasts to teach key concepts within their specific disciplines and how are these applied?

The findings focus on the first two research questions outlined in Chapter 4, as questions 3 and 4 are focused on discussing the findings in a particular light (RQ3 focuses on socio- cultural practices and situated context, while RQ4 considers the implications of the findings for an understanding of online teaching).

- How can the use of a multimodal inquiry (MMI) framework, developed by the thesis researcher, that builds on an Inquiry Graphics approach, support the teaching of key disciplinary concepts? This question includes the following subquestions:
    a) How are key disciplinary concepts articulated through the multimodal ensemble of the screencast?
    b) How are conceptual ideas and screencast elements brought together?

The following table presents an overview of the main themes revealed in the analysis of the screencasts and the qualitative interviews.

Table 5:1: Overview of themes from the findings

The Multimodal Screencast	**Technology Enhanced Learning (and Teaching)**	**Teaching and Learning in Higher Education**
A multimodal sign for communication	Digitally literate/fluent Practitioners	**The development of students' knowledge in the discipline:**
The screencast as a multimodal ensemble:	Lecturer as Learning Designer	-Knowledge as developmental, fluid
Graphic-Pictorial Mode: -Unprobed representations -Semiotic Articulation -Semiotic Invitation	Sociomateriality of Digital Technologies	-Situatedness of the Teacher and the Learner
Linguistic Mode: -The Language of the Discipline -Enacting Relational Teaching	Developing Critical Media Literacy	-Concepts as pluralistic and evolving entities
Aural Mode: -The Voice of Teaching -Music as a Teaching tool	New ways to organise information (inclusive and accessible)	-A Participatory Approach to online teaching and learning
Spatial-Design Mode: -Enacting software features for teaching and learning -Universal Design & Accessibility		**Teaching Approaches embodied in the screencast:**

Interconnectedness of Modes		-Student as apprentice within a Community of Practice
Major & Minor Modal Carriers of Screencast Content Meaning		-Relational Teaching
Inquiry Graphics- unpacking the visual		-Signature Pedagogies
The Multimodal Inquiry Framework		-Scaffolded Instruction

5.2. Articulation of disciplinary concepts through the screencast

5.2.1. Units of analysis

The challenge of analysing video lies in the decisions around how much data to select. Jewitt (2012) suggests selecting fragments or episodes from the video, which highlight key areas in relation to the research questions (using a deductive approach), or using an interactive, abductive approach to discover key concepts for analysis. For this research study, it was decided to first focus on:

- all screencasts
    1. to explore and present an initial overview of all screencasts included for analysis, and
    2. to outline salient modalities and patterns, along with examples of unique approaches in the screencast data as a whole. Following this, I turn my focus to
- individual screencasts
    1. to provide an in-depth insight into the screencasts and their relationship with knowledge. For this purpose, three screencasts were selected based on specific criteria, as explained in Chapter 3.

While the use of Key Moments (KM) identified by the participant provides a natural zoom-in opportunity for analysis, a holistic view is also adopted (zoom-out) to provide evidence of claims made.

Where quotes relate to the screencast text, they will include the timestamp in brackets,

e.g. [12.3-12.9] in addition to the lecturers' pseudonyms and their academic discipline. In contrast, quotes from the qualitative interviews will just include the lecturers' pseudonym and the relevant discipline.

I chose to integrate both screencast data and interview data in a number of cases to provide a holistic view of the themes that emerged in the analysis. However, at certain points I refer to screencast data or interview data separately, to illustrate how my analysis of the screencasts using the MMI framework is supported by the lecturers' observations or inversely, how the observations made by lecturers relating to the modal affordances of the screencast are reinforced through my analysis of the screencast using the MMI framework. It is worth noting that while the focus of my analysis is on the lecturers' design choices and the embodiment of these in the multimodal screencast, I am also a reader, in much the same way as the intended audience, i.e., the students. However, as a reader-analyst, my interest lies in examining the affordances of the multimodal screencast for learning, rather than as a means to develop my disciplinary knowledge in a particular domain. Therefore, while I can engage with the three spaces of meaning-making as described by Rose (2016), i.e., the intentionality of the creator, the agency of the artefact and the "specificity of the viewing" (p. 44), my analysis in relation to the viewing of the screencast is limited to a researcher's perspective.

5.3. All screencasts: Disciplinary Mapping

The following section presents an overview of the screencasts, before drilling down into more in-depth analysis of a selected number of these multimodal digital artefacts. The screencasts span a range of academic disciplines and functional areas, the breakdown of which is indicated in the chart below. These academic discipline and functional areas correspond to the organisational structure within the research site.

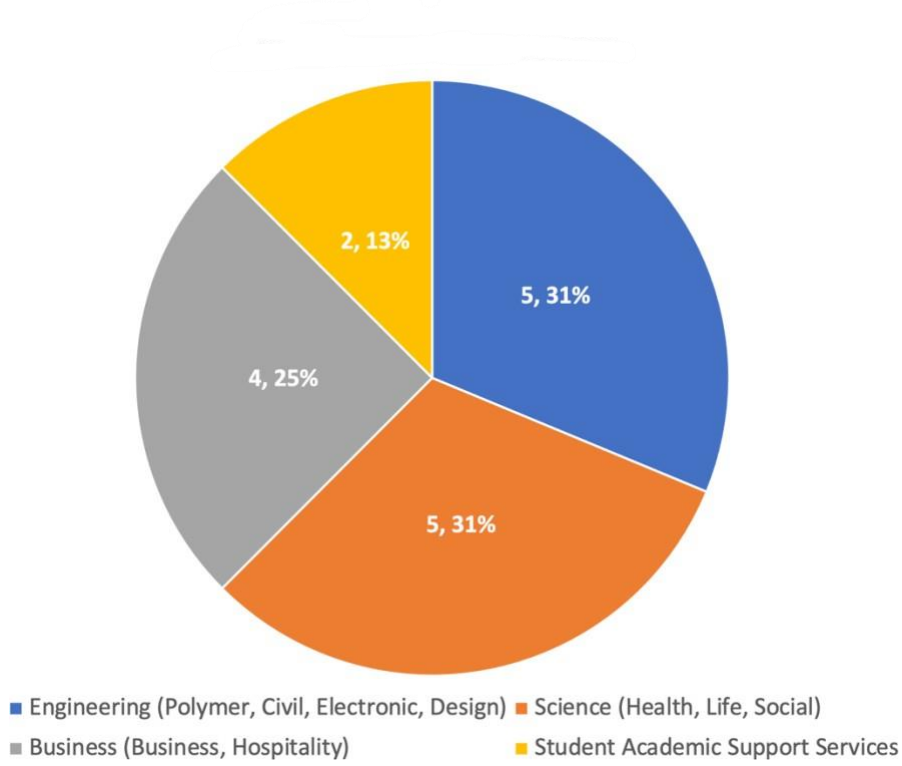


Figure 5:1: Breakdown of discipline/functional areas

5.4. Overall function of screencasts

From the 16 screencasts included for analysis, 63% (*n=10*) used the screencast to explain a theoretical concept within the discipline, while 12% (*n=2*) demonstrated how to use specific features of software package. In 25% of cases (*n=4*) the screencasts had elements of both, e.g., an explanation of the concept at the beginning of the screencast, followed by a walkthrough of the relevant software application or website and in some cases a summary of the learning objectives at the end of the screencast.

The following chart indicates the spread of years amongst the target student audience, with the majority (42%, *n=8*) of screencasts created for first years, while 5% (*n=2*) were created as a general resource for students.

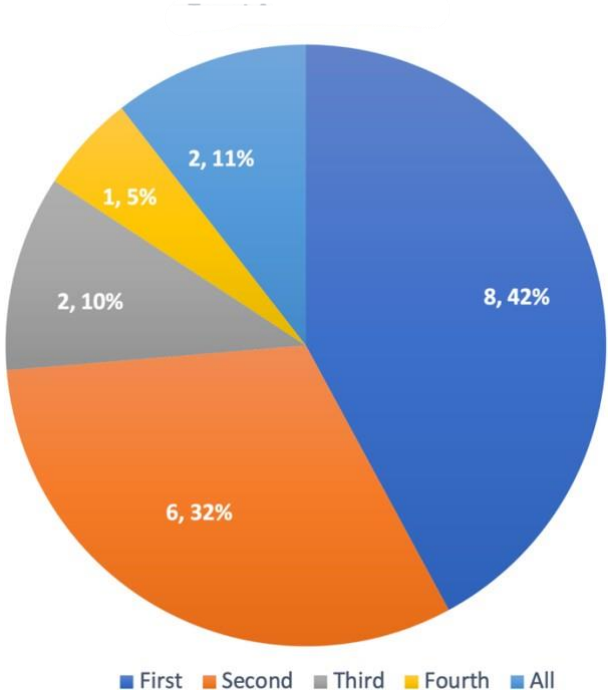


Figure 5:2: Target student audience (years)

5.5. The range of disciplines represented

The table below provides a breakdown of the range of concepts presented, grouped by specific discipline area. An overview of the screencast topics and the discipline to which they belong are included, together with the length of each of the screencasts and the intended target audience. The average duration of the screencast is 6:22 minutes, with just over half (*n=56%*) between 4-6 minutes long, 31% (*n*=5) in the 7–10-minute range and 13% (*n=2*) in the 1–3-minute range. The range of disciplines presented and intended target audience make a case for the generalisation of results from the study.

Table 5:2: Detailed breakdown of discipline area and title of screencast

Discipline	Concept presented in screencast	Length of video (minutes)	Student Year
Civil Engineering	How to get started in Matlab	7:44	Final (4th)
Polymer Engineering	Matter	6:45	First
Electronic Engineering	Full Wave Rectification	6:57	First
Electronic Engineering	Introduction to Transformers	5:04	First
Chemistry	Calculating Concentrations	4:24	First, second
Environmental Biotechnology/ Microbiology	Microbial Bioplastics	4:28	Second, third
Pharmaceutical Science	How to access and use the BNF Online	3:57	First, second
Audiology	The psychological effects of hearing loss on patients	6:42	Second
Social Sciences	Social & Emotional Benefits of Physical Activity	5:58	First
Animation	Vector 2D animation	7:35	Second
Business Studies	Local Area Networks	9:26	Third

Quality Management	The Seven Quality Tools - The Histogram	6:49	First
Academic Writing	Referencing using MS Word	8:51	All students
Disability Services	Using Read & Write for exams	3:11	All students
Culinary Arts	Food allergy and food intolerance - what is the difference?	7:50	First
Computer Applications for Hospitality	Creating relationships in MS-Access Database	6:20	Second

The following section proceeds to focus on the use of the multimodal inquiry (MMI) framework that was developed to extend an Inquiry Graphics framework (Lacković, 2020). The purpose of this is to inquire multimodal screencasts developed by university educators, to understand how various multimodal elements relate to teaching concepts across disciplines through screencast presentations.

5.5.1. The Multimodal Inquiry (MMI) Framework: Exploring the Multimodal Ensemble of Lecturers' Screencasts

This section examines the composition of the multimodal screencast using the MMI framework, explained in Chapter 3. The purpose is to identify how each of the modalities are used and / or combined to present the disciplinary concept. Initially, I consider each of individual modes included in the multimodal ensemble (Layer 1 of the MMI). Following this, I move to the second layer of the MMI, to explore how the Inquiry Graphics Analysis revealed lecturers' meaning-making practices. Finally, I focus on how lecturers' pedagogical approaches are embodied in the screencast, either explicitly or implicitly. The MMI framework is included below for the reader's convenience and the multimodal ensemble (Layer 1, inner circle) is analysed in the following order:

1. Graphic-Pictorial Mode
2. Linguistic Mode
3. Aural Mode
4. Spatial-Design mode

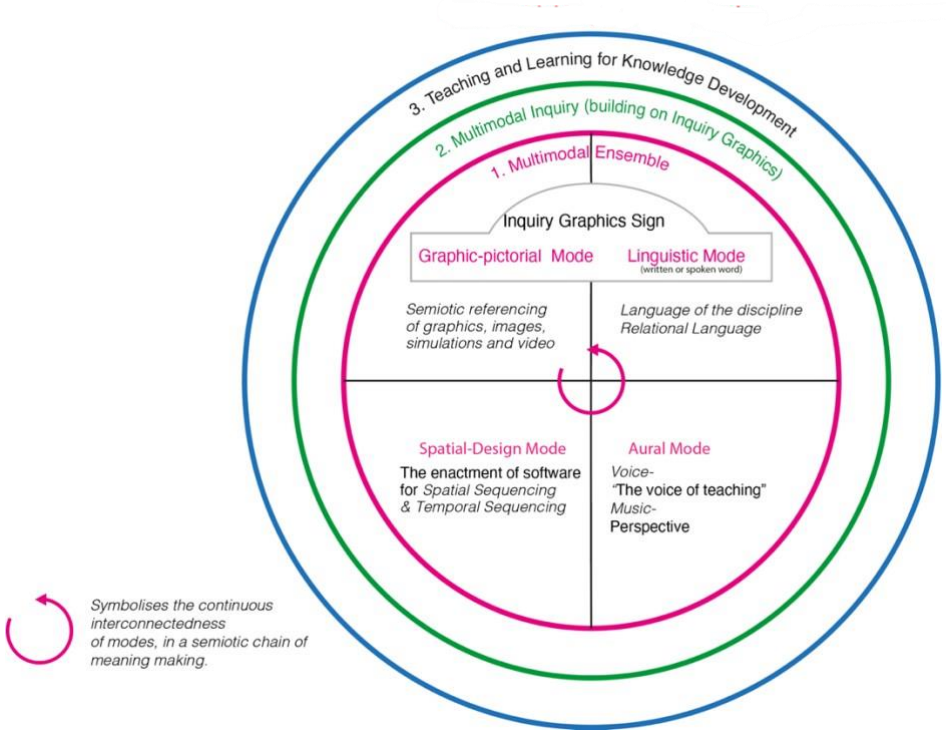


Figure 5:3: The multimodal inquiry (MMI) framework

5.6. Understanding the Screencast as a Multimodal Ensemble: Graphic-Pictorial Mode

This section focuses on the use of visual elements, coded as graphic-pictorial signs within the screencast. A breakdown of the different graphic-pictorial elements coded during Phase 2 of the analysis is presented in the table below. Seven categories of graphic-pictorial elements were identified, with the most popular in the *Graphic Symbols* category. This category included graphics available to users within PowerPoint, Camtasia and Screencastomatic (screen casting software), as well as logos and software icons, and accounted for 33% (*n=48*) of the overall total number of graphic-pictorial elements.

Illustrations was the second largest category (29%, *n=43*) and included conceptual drawings and schematics, as well as diagrams created by the participant or captured from other sources and comic stories. *Text used as images* was chosen as a classification for instances of text used as an image, e.g., words with stylistic features applied such as drop shadow, as well as word clouds. *Simulations / Animated Graphics* refers to the instances of software and process simulations included in the screencasts.

The overarching findings from the analysis of the graphic-pictorial mode suggest that while visual elements are used in over one third of the screencasts, these are mainly unprobed representations of the concept in question and are in many cases merely included to catch the viewer's attention.

Table 5:3: Categorisation of graphic-pictorial elements

Graphic-pictorial Element	Number
Photographs	31
Illustrations	43
Charts and graphs	9
Text used as an image (e.g., word clouds)	5
Graphic symbols (e.g., software icons, call outs,)	49
External video (either with original narration or with narration by the participant)	8
Simulations /Animated Graphics	3
Total	148

In total, there were 148 graphic-pictorial elements used within the 16 screencasts. Examples of these and their uses are included below.

Photographs

This collage of photographs is included at the beginning of a screencast which focuses on the Social and Emotional Benefits of Physical Activity. The lecturer references the concept which is depicted in these photographs (unprobed representation - depictional). However, they do not invite students to interrogate the photographs in any way.

Figure 5:4: Social and Emotional Benefits of Physical Activity (Social Sciences)

In contrast, the following frame presents a series of photographs which are referenced directly by the lecturer (semiotic articulation) as they explain the concept:

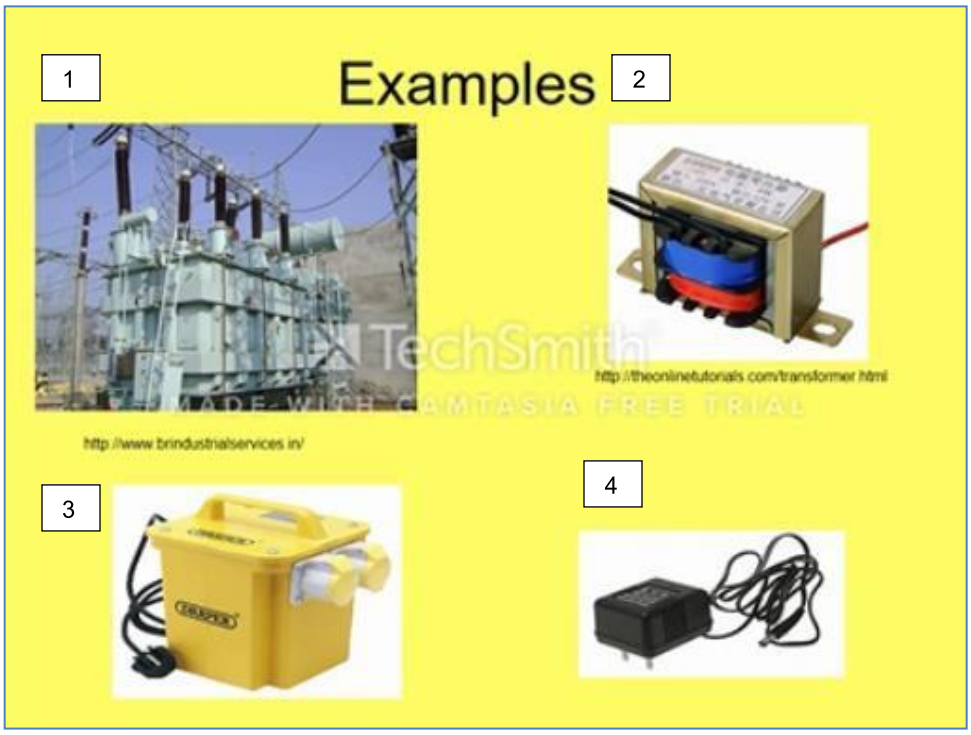


Figure 5:5: Introduction to Transformers (Engineering)

The photographs (P1- 4 above) are added to the slide incrementally using PowerPoint animation, and the lecturer structures the narrative around the real-world representation of the concept being presented:

[Timestamp: 0:21.4-1:06.1] *"(P1) This is what a transformer would look like in a substation; (P2) here we have a relatively small transformer that you would find in a PC*

or maybe in the back of your TV at home. This transformer here (P3) converts 230 volts AC down to a safe 110-volt AC. This transformer would be used by tradesmen on a building site to power tools. Inside the enclosure there, you. would also have a transformer (P4). These transformers would be used for baby monitors or maybe as a charger for some of the older mobile phones" (**James, Engineering Lecturer).**

Illustrations

A variety of illustrations were also used to explain the concept in the screencast. In some disciplines, e.g., Engineering, schematics provided a pictorial representation of the concept, while in others, e.g., Science, illustrations were used to visually explain the concept on screen, such as the one below:

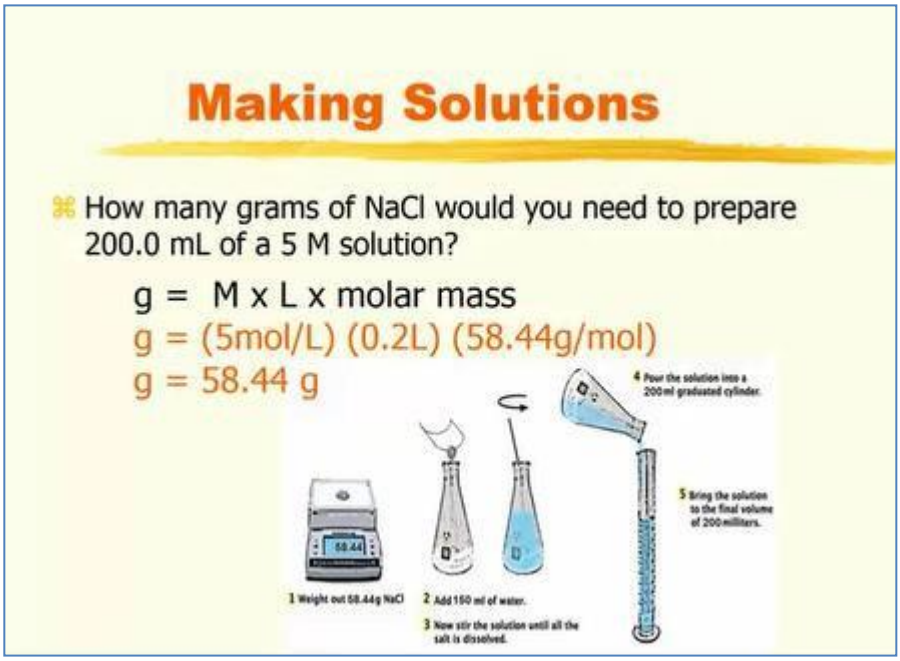


Figure 5:6: Making Concentrations (Science)

The pictorial representation of the process of making solutions is included but not referenced (unprobed representation-depictional) in the narration. In the qualitative interview the lecturer explains their rationale for including pictorial representations, as they themselves are *"more of a picture learner than [they] are a words learner"* **(Joseph, Chemistry Lecturer).** In the example below, an alternative type of illustration, i.e., a schematic is used to explain the DC Power Supply and semiotic articulation is evident as the lecturer uses the mouse pointer to move along the schematic, explaining the focus of the screencast.

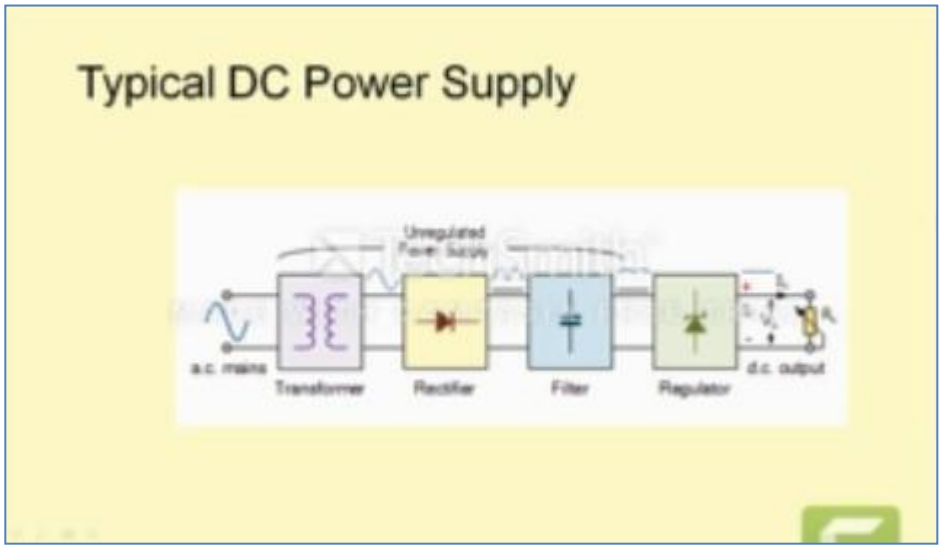


Figure 5:7: Full Wave Rectification (Engineering)

Text used as Image

Word clouds have become increasingly popular to summarise large amounts of text relating to a concept in pictorial form. Using an online word cloud generator, words with greater frequency within a body of text can be given more visual weight. The use of a word cloud as a pictorial representation of text is included in one of the screencasts in the dataset, but is not referenced by the lecturer (unprobed representation-depictional).The slide below includes two examples.

Figure 5:8: Food Allergies and Food Intolerance (Business)

Charts & Graphs

These are common pictorial signs in numerical disciplines and therefore worth including in the analysis of visual representations of disciplinary concepts. In the following example, the pictorial histogram is used as the basis for the tabulation of data within a business context and the lecturer references elements within the visual sign to explain the concept.

Figure 5:9: The Histogram (Business)

Graphic Symbols

Graphic symbols constitute the most widely used visual representations and include a variety of visual signs, ranging from PowerPoint features such as SmartArt graphics to shapes and icons, which represent the concept in a particular sociocultural context.

In the example provided below, the lecturer references the text elements on screen to explain the concept (software components) but anchors the meaning within their socio-cultural context using pictorial signs to which they do not refer explicitly (unprobed representation- depictional), but which may be familiar to students. The lecturer suggests *"the picture illustrates the understanding. Anyone can learn off a one-word definition"* **(Robert, Business Lecturer).**

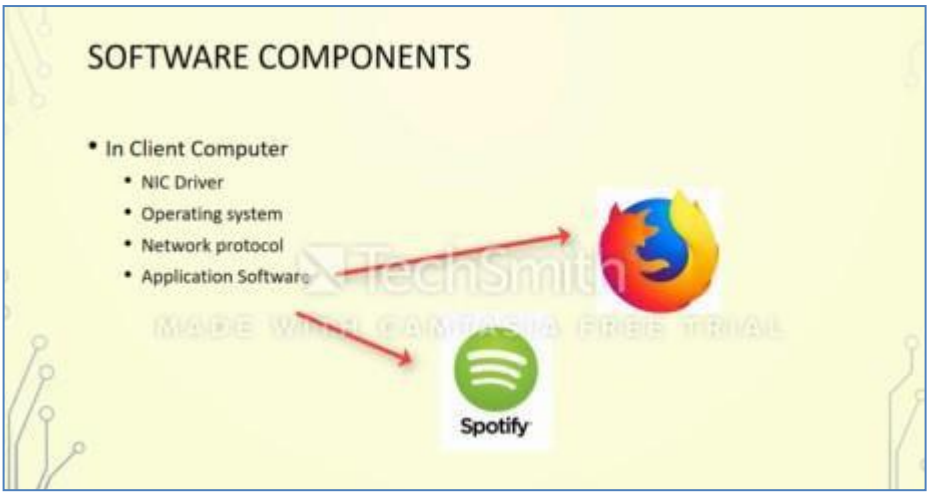


Figure 5:10: Local Area Networks (Business)

In the example below, the lecturer reinforces the concept using a callout arrow, which includes text. The shape (or sign) is not referred to (unprobed representation-depictional) but draws attention to the structure of the citation within the paragraph and provides the academic term associated with the action.

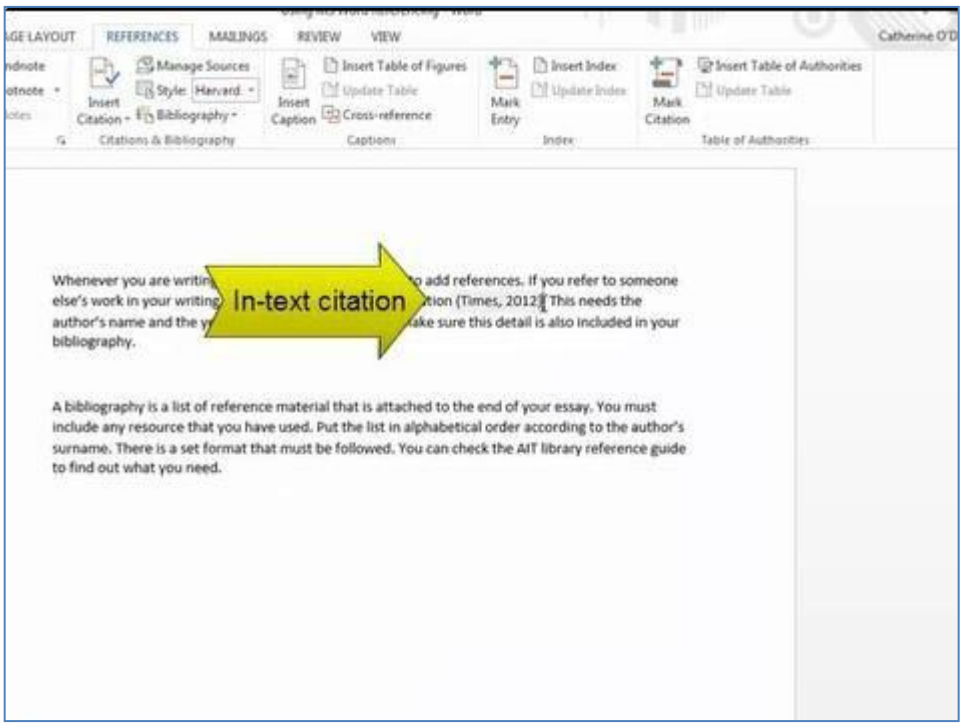


Figure 5:11: MS Word Referencing (Academic Student Support)

Taught concept and graphic elements: how are they brought together?

Following the initial categorisation of graphic-pictorial elements, they were subsequently analysed at the intersection of image/speech to explore how visual representations of the concept were included in the screencast composition. In Table 5.4 below (adapted from Hallewell & Lacković p.1172) the semiotic referencing of the graphic-pictorial elements is explained as it relates to the lecturer's narration of the screencast. The prevalence of graphic-pictorial elements across the screencasts suggest that lecturers are attempting a visual materialisation of the concept, yet semiotic interrogation features rarely, and the use of critical semiotic exploration is not present.

Table 5:4: Semiotic referencing and application of images (Hallewell & Lacković, 2017)

			Instances across 16 screencasts
Unprobed Representation	Attentional	The image (illustration or photograph) is not *mentioned* in the lecturer's narration of the slide.	18
	Depictional	The image features in the lecturer's narrative but is not directly referred to.	38
Semiotic Articulation		The lecturer's narrative references the image or elements within the image as they relate to the concept.	39
Semiotic Interrogation Invitation		The lecturer invites the viewer (student) to interrogate the image or some of its elements and related meaning.	3
Critical Semiotic Exploration		The image is analysed critically by the lecturer.	0

A more detailed breakdown of the semiotic referencing for all 16 screencasts is included in the table below, with the number of instances for each category listed under each screenc

Table 5:5: Semiotic referencing within the screencasts

This includes the total number of instances of semiotic references for each category and the breakdown for each screencast.

	Concentration Revision	Full Wave Rectification	Local Area Networks	The Histogram	Introduction to	Social & Emotional	Vector 2DAnimation	BNF Online	Food Allergy /Intolerance	Effects of Hearing Loss	Relational Databases	Microbial Bioplastics	Matter	MS Word Referencing	Read & Write for Exams	Matlab
Semiotic Articulation (39)	2	10	3	8	6	2	1	1	3	2	2	-	-	-	1	-
Semiotic Interrogation Invitation (3)	-	1	-	-	-	-	-	-	-	-	-	-	2	-	-	-
Unprobed Representation – Attentional (18)	2	1	-	-	-	3	4	1	2	1	-	1	-	3	-	-
Unprobed Representation – Depictional (38)	-	-	5	3	1	4	1	6	2	3	-	10	1	2	-	-
Critical Semiotic Exploration (0)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

External Videos embedded in the screencasts

The use of external videos can provide additional information relating to the concept or demonstrate a real-world application of conceptual knowledge. 44% (*n=7*) of the screencasts analysed include a video from an external source. The table below provides further details on these external resources and distinguishes between those used as an add-on to further explain the concept, or external videos used as an integral part of the explanation provided by the lecturer. The length of external video ranged from 0:26 seconds to 2:74 minutes, with the average duration of 1:29 minutes, and the most common positioning of the video was either midway within the screencast (with content presented both before and after the video), or at the end of the screencast. There was also some variety in how the video was integrated within the screencast. In some cases, the original narration was muted, and a narrative provided by the lecturer; in other cases, the original narration was included. The positioning of the external videos is categorised as follows:

- Screencast finishes with external video – End
- Screencast begins (perhaps after short introduction) with external video – Beginning
- Screencast includes content both before and after the external video – Middle

Table 5:6: Details of external videos included in the screencasts

Discipline - Concept	Original Narration (ON) or Narrated by Participant (NP)	Brief description of concept	Length of external video	Position of video in screencast (Beginning, Middle, End)
Student Academic Support Services- MS Word Referencing	Soundtrack only - no narration	What is plagiarism? Victory image and “Dangerous” song	0:84	Beginning (0:24 sec)

Audiology- The psychological effects of hearing loss	Original Narration – US voice (with background soundtrack)	Personal narrative from woman suffering with progressive hearing loss	2:74	Middle (1:39)
Civil Engineering- Matrices	Original narration – Eastern voice	Instructional video explaining matrices	1:04	End (5:15)
Engineering- Matter	Original Narration-US voice) (animation)	Explains what matter is	0:26	Middle (3:00)
Hospitality- Food Allergies & Food Intolerance	(Original Narration - US voice) (animation included)	Body's reaction to allergens	2:26	End (5:21)
Science- Microbial Bioplastics	Narrated by the lecturer (animation included)	PHAs – what they are and how they are grown in the lab	1:05	End (3:19)
Engineering- Full-wave rectification	Narrated by lecturer (own video)	Use of light emitting diodes on a bridge	0:82	Middle (3:55)

For some participants, the rationale for including an external video was determined by the assessment criteria within the TEL module they were undertaking, which required participants to include a video related to the concept. However, not all participants were required to meet this criterion, as the assessment criteria changed during the data collection period. Where an external video was included, participants indicated their rationale for the choice of video during the qualitative interviews. In some instances, it was an attempt to engage students or capture their attention:

"I wanted to put in a definition. And I was trying to find something that would stand out to grab attention because you know, everyone keeps talking about plagiarism, but

nobody takes a lot of interest in it" **(Martina, Student Academic Support Lecturer)**.

Some of the participants opted to include videos to supplement their teaching of the concept in question:

"It really illustrates within the cell, you know, what is actually happening" **(Aoife, Science Lecturer)**.

In the detailed analysis of the subset of data in Chapter 6, I explore further the inclusion of external video in two of the screencasts included above.

Simulations embedded in the screencasts

Simulations provide a dynamic representation of conceptual knowledge and were included in 25% (*n=4*) of the screencasts created by lecturers within the Faculties of Science, Engineering and Business, to further illustrate the concept presented. The average duration of the simulations is 1:46 minutes and 75% (*n=3*) are embedded within the screencast, with content presented both before and after the simulation. In three of the four simulations, the narration is provided by the lecturer, while one simulation is narrated by its original author. The table below provides additional details on the simulations.

Table 5:7: Details of simulations included in the screencasts

Discipline - Concept	Description of simulation	Original Narration (ON) or Narrated by participant (NP)	Length of simulation (minutes)	Position of simulation in screencast (Beginning, Middle, End)
Engineering- Full wave rectification	Simulation of diode bridge rectifier circuit	Narrated by participant	1:16	5:24 (Middle)
Science – Microbial Bioplastics	Great Pacific Garbage Patch-	Narrated by participant (extract taken	1:19	1:18 Middle

	simulation of currents / vortex	from video on YouTube™)		
Engineering-Introduction to Transformers	Simulation of operation of a transformer	Original Narration – British voice	1:81	3:23 End
Business-Histograms	Simulation of how results are tabulated in a histogram	Narrated by participant	0:97	1:19 (Middle)

The example included below comes from the simulation of a *"diode bridge rectifier circuit"* **(Brenda, Engineering Lecturer).** Here the lecturer uses the simulation to explain the concept in action, i.e., full wave rectification. The simulation shows the direction of the current and enables the lecturer to explain the process, as though it were a real-world event.

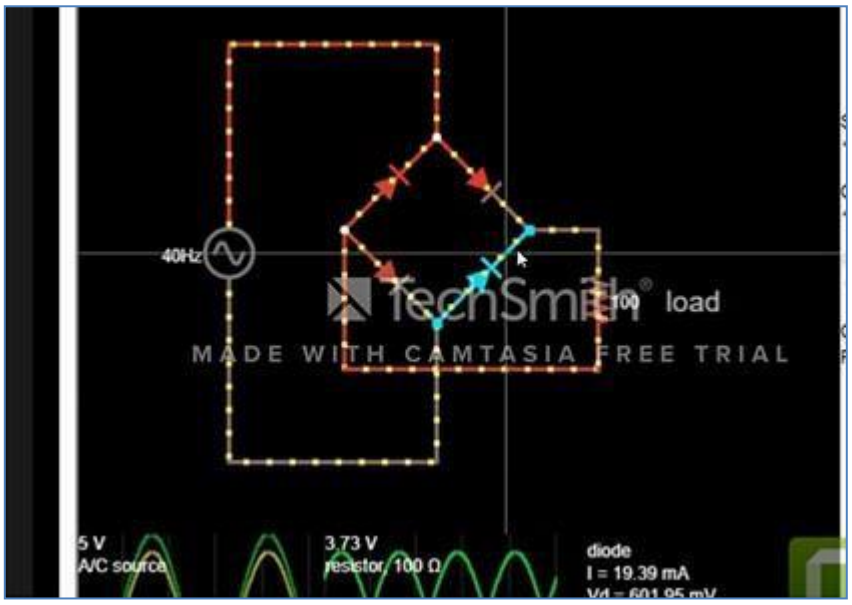


Figure 5:12: Full Wave Rectification (Engineering)

The section above analysed the pictorial representations of disciplinary concepts as included in the multimodal screencast. While a significant range of graphic-pictorial elements were included, very few were used for semiotic articulation of the concept, or as a tool for critical engagement. This represents a missed opportunity for lecturers to explore students' understanding of the concept from different perspectives. In the following section, we move to the linguistic mode and the modal affordances examined

within the screencast.

5.7. Understanding the Screencast as a Multimodal Ensemble: Linguistic Mode

In this section I consider the linguistic mode of the multimodal ensemble, which I understand as a textual-verbal mode, focusing specifically on ***what was written and what was said*** by faculty to explain the disciplinary concept, rather than ***how things were said*** (which is dealt with under the aural mode). Initial coding revealed themes such as disciplinary language, i.e., vocabulary specific to the discipline, and relational language, i.e., language used to create a social rapport or connection with the students. Following this initial coding exercise, a further coding cycle analysed all 16 screencasts to identify the prevalence and usage of specific disciplinary language, as well as the positioning and use of relational language in the narration provided by the lecturer.

Relevant quotes from the qualitative interviews in relation to both themes are included to support the findings, as well as examples from within the screencasts.

Disciplinary Language and Literacy

Each discipline has a specific vocabulary and during the analysis of the screencasts, examples of specific disciplinary language in use were identified. During the qualitative interviews, some participants recognised the challenges associated with learning this new vocabulary:

Joseph, Science Lecturer:

"*I suppose one of the jokes I used to make is unfortunately there's a lot of chemistry terms early in their chemistry career that all begin by M and all mean something different*."

In some cases, students' disciplinary language evolves over time, as they learned the *"vernacular of the industry"* **(Robert, Business Lecturer)** with the help of the lecturer. Interestingly, one lecturer felt that subjects like Science or Biology had a specific vocabulary with *"foreign terms"*, whereas their subject wasn't quite the same: *"I suppose […] I wouldn't consider it. […] But to me, you know, I talk about stuff like voltage current, resistance, AC DC"* **(Brenda, Engineering Lecturer).**

As content experts designing and creating the screencasts, lecturers drew on their disciplinary expertise to present the concepts articulated in the screencasts. For some

screencasts, where the lecturer introduces a new concept, a multimodal explanation of the terms used is provided, both in the narration and on screen. In the example below, a definition is provided for the term *diode*, along with a pictorial representation of the concept. In addition, the lecturer further explains the concept through narration.

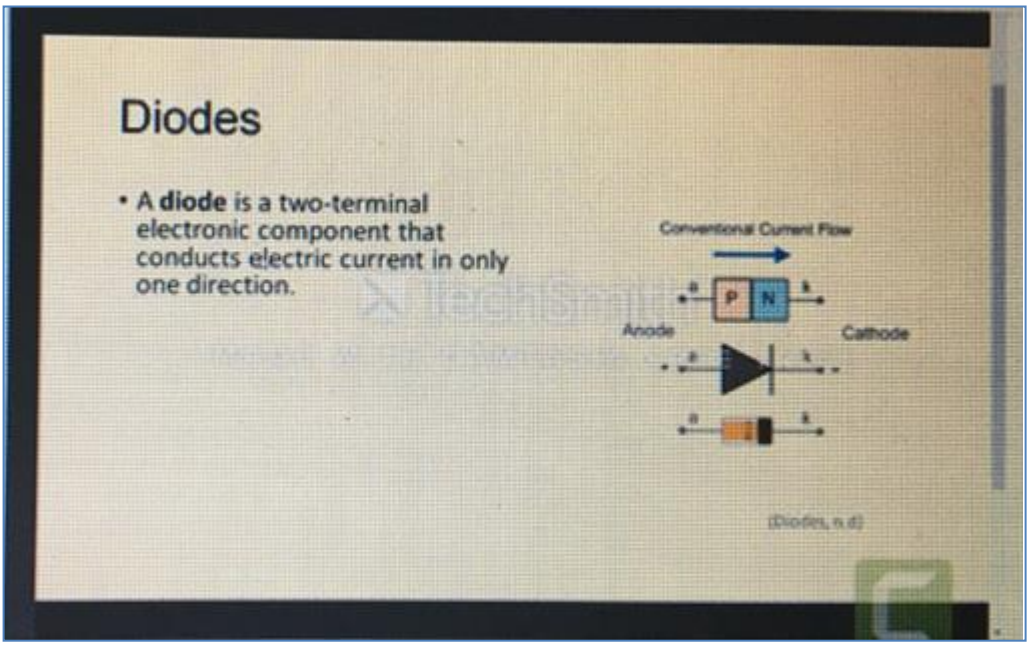


Figure 5:13: Slide #3 Full Wave Rectification

[Timestamp: 0:29-0:42.3] *"We know that a diode is a two-terminal device, and it has a positive input called the anode and a negative output called a cathode"* **(Brenda, Engineering Lecturer).**

Similarly, the slide below provides a definition of the concept of a Local Area Network and situates this in a familiar sociocultural context.

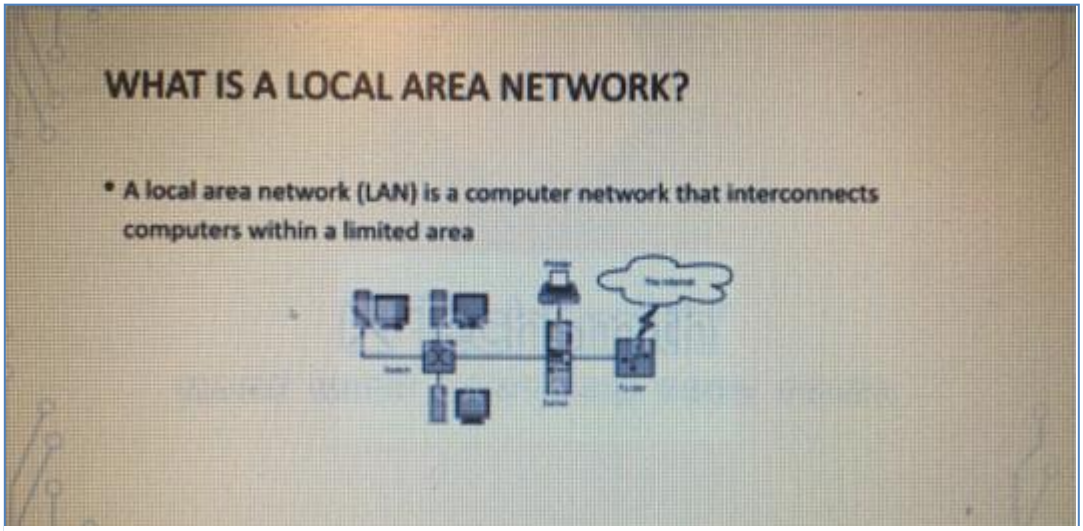


Figure 5:14: Slide #3 Local Area Networks

[Timestamp: 0:18.1-1:31.6] *"A local area network or LAN is a computer network that interconnects within a limited area. An example of which would be your house where you'd have a home broadband connection, and you'd allow a number of different laptops or PCs or smart TVs or personal devices to connect to it"* **(Robert, Business Lecturer).**

In other screencasts, the concept is introduced with an assumption that students are familiar with the terms used to explain the concept. In the example below the lecturer uses the term 'referential integrity', without explaining it: *"To complete the relationship, I enforce referential integrity and click on the create button"* [Timestamp: 3:17.9-3:23.9]. They explained in the interview why they chose this approach:
"In the classroom, I really focus in on referential integrity as a concept, it's possibly too difficult to explain within the framework of a short screencast. And I think […] I would lose the focus of what I want them to do" **(Saran, Business Lecturer).**

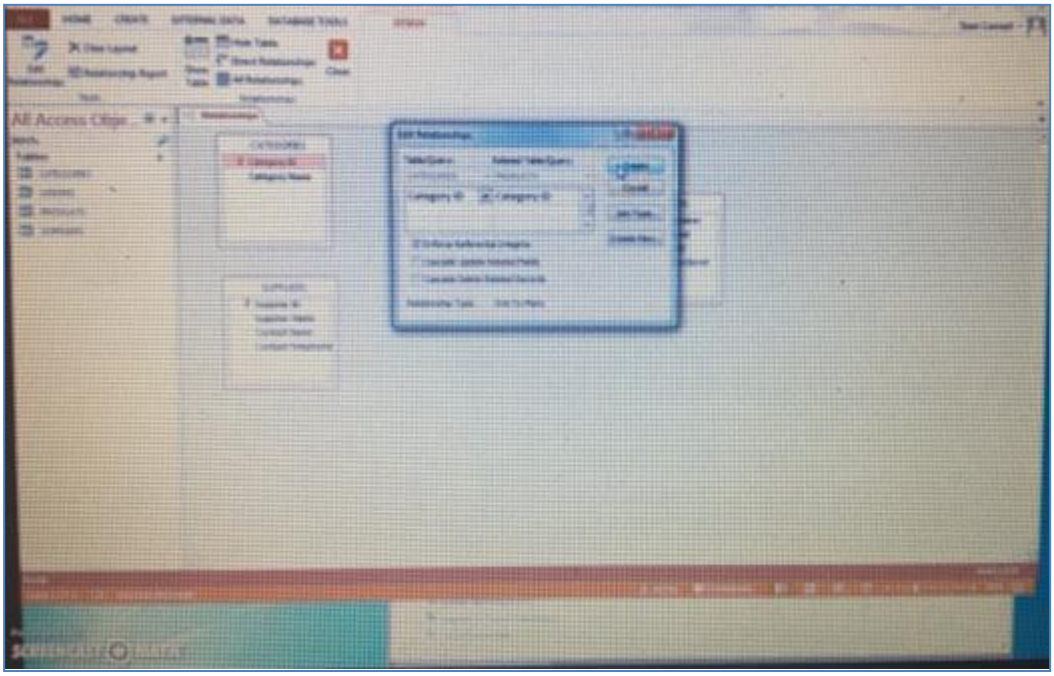


Figure 5:15: Relational Databases (Business)

In the example below, the term 'tween' is used without explanation, assuming students were familiar with its purpose.

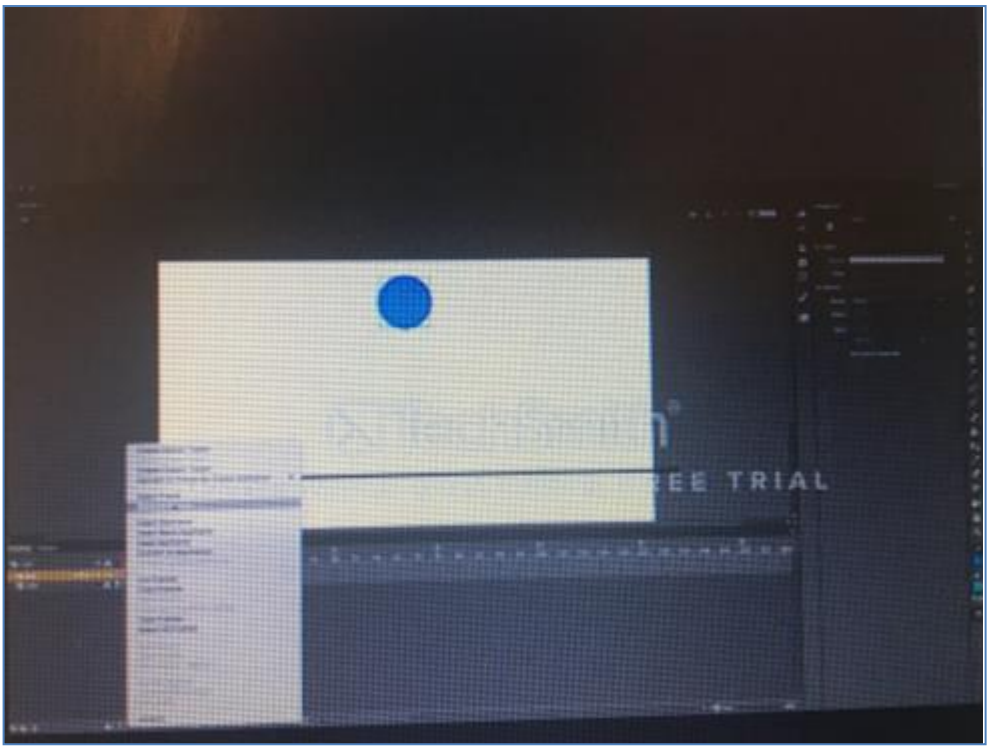


Figure 5:16: Vector 2D Animation (Engineering)

[Timestamp: 3:04.1-3:11.7] *"But before we do that we should actually add in our tweens, which we're going to do now in a second, so we're going to go to frame 1, right click, create classic tween"* **(Frank, Design Lecturer)**.

Each of the screencast frames above demonstrates how the *language of the discipline* is used to present or explain the concept. Analysis of the screencasts revealed specific linguistic choices in terms of how lecturers chose to present the key concept to their audience. In some cases, the teaching approach is didactic, while in other screencasts, there are clear indicators of relational teaching. This is explored further in the following section.

Relational Teaching

This discursive relationship with the listener/viewer or differentiation competence (Aspelin, 2015) is notable in many of the screencasts, where lecturers use the pronouns 'I' or 'we' as they include themselves in the learning activity or the use of 'you', to speak directly to the student. The graphic below shows the varying degrees of differentiation competence identified within the screencasts' narration, as a representational summary. While the existence of one level does not exclude the presence of others, they help to identify the primary focus of the discursive relationship within the screencasts.

Figure 5:17: Levels of discursive relationship with the listener (differentiation competence, Aspelin, 2015)

Further details about the levels of differentiation competence within the screencasts are provided in the following table:

Table 5:8: Levels of Differentiation Competence

Concept presented in screencast	Instances of "I"	Instances of "You"	Instances of "We"	Total
How to get started in Matlab	1	7	28	36
Matter	8	14	20	42
Full Wave Rectification	0	8	31	39
Introduction to Transformers	0	2	7	9
Calculating Concentrations	0	19	9	38
Microbial Bioplastics	0	1	1	2
How to access and use the BNF Online	3	8	21	32
The psychological effects of hearing loss on patients	0	12	7	19
Social & Emotional Benefits of Physical Activity	2	34	10	46
Vector 2D animation	8	8	66	82
Local Area Networks	0	13	10	23
The Seven Quality Tools - The Histogram	5	7	22	34

This discursive approach can be summarised visually:

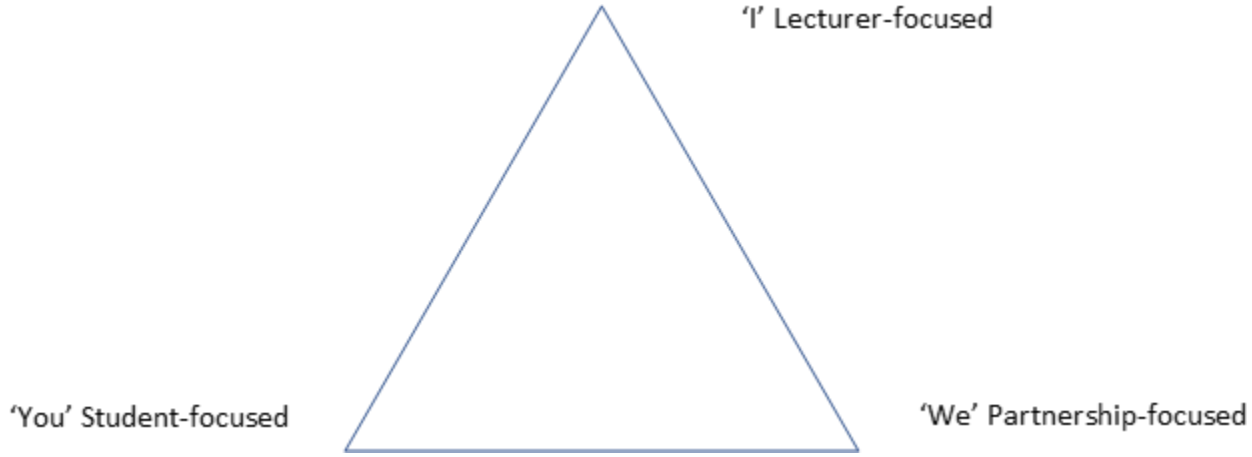


Figure 5:18: Discursive relationship with the listener as a focused activity

At level one or two, there is little evidence of a relational focus, while at level three there is evidence of considering the students' experience and speaking directly to the student. This may be to advise them on how the concept is embedded in their personal lives (*Social & Emotional Benefits of Physical Activity*), academic lives (*Calculating Concentrations, Matlab, MS Word Referencing*), or future professional lives (*Emotional Effects of Hearing Loss, BNF Online).* The most prevalent approach is at level 4, a partnership-focused teaching approach. The use of 'We' is most notable in the screencast on Vector 2D Animation (Engineering), where the pronoun is mentioned 66 times throughout the screencast. The lecturer positions themselves as a learner completing the task, but also narrates the process as an expert:

[Timestamp: 1:59-2:09.2] *"We're going down to our timeline, we're going to make this last for 1 second, so we're going to go to Frame 25 and we're going to say insert Key Frame by right-clicking and insert Key Frame or we can press F6"* **(Frank, Design Lecturer).**

Participants also referenced their preference for this partnership style of teaching during the qualitative interviews, particularly in disciplines with a practical component:

"[It was] teaching as opposed to lecturing because it was problem solving all the time. So, when they came in the door, I asked them, what area they were stuck with, and then we tackled that area" **(Joseph, Science Lecturer).**

While the choice of language may have been a subconscious one, the attempts to enhance or nurture a social bond with students through the screencast was explicit. In some cases, reference is made to lived experience of students, as in Keith and Sophie's screencasts below:

Keith, Science Lecturer:
[Timestamp: 3:52.4-3:57] *"Hopefully, now you'll be much more comfortable with using the BNF Online for all your medicines-related queries"* (How to access and use the BNF Online).

Sophie, Social Science Lecturer:
[Timestamp: 0:53.9-1:06.2] *"For you as students, I always recommend taking regular study breaks, go for a short walk, do a little bit of Pilates or yoga stretches, it will help you remain focused for your work"* (Social and Emotional Benefits of Physical Activity).

In other cases, personalised strategies are used by the lecturers, as outlined in the table below.

Table 5:9: Personalised strategies used by the lecturers

Personalised Strategy	Screencasts where examples of this were found
Welcoming their students.	• Matter • How to get started in Matlab • The Seven Quality Tools - The Histogram • Vector 2D Animation • Creating relationships in MS-Access Database • How to access and use the BNF Online • The psychological effects of hearing loss on patients
Introducing themselves.	• Referencing using MS Word • Food Allergy and Food Intolerance- What is the difference? • Matter
Wishing their students good luck.	• Using Read & Write for exams
Mentioning the specific programme the screencast is relevant for.	• How to get started in Matlab • Matter • Vector 2D Animation

	• The psychological effects of hearing loss on patients
Thanking the viewer for watching/ listening.	• The Seven Quality Tools - The Histogram • Food Allergy and Food Intolerance- What is the difference? • Full Wave Rectification • Calculating Concentrations

The screencast embodies lecturers' relational pedagogy through the linguistic choices they make, whether consciously or unconsciously.

5.8. Understanding the Screencast as a Multimodal Ensemble: Aural Mode

In this section, the focus is on the use of voice and music as the embodiment of the lecturers' instructive mode to teach a key concept.

Voice

This analysis notes ***how things are said*** (in contrast to the previous section, which focuses on ***what was said***), and includes the prosodic features of the voice, in particular intonation and vocal melody, volume (stress), pace (or rhythm), how these are used in the screencasts and referenced within the qualitative interviews. I also consider interpersonal communicative competence as a characterisation of lecturers' personality, noting the discourse markers they use within the screencast to fulfil specific textual functions.

In some of the screencasts the deliberate use of specific prosodic features of the voice indicates how the lecturer intends to articulate the concept; in other screencasts it does not appear to be an important semiotic resource.

Pitch patterns indicate the intention behind a word and can communicate meaning in a particular way. In 75% (*n=12)* of the screencasts analysed, intonation was employed to emphasise the importance of these key conceptual pointers. The table below indicates in bold where the intonation is placed to highlight key messages the lecturer wishes to communicate.

Table 5:10: Examples of screencast transcripts where intonation is used (bold text added to highlight emphasis)

Screencast	Code
The Seven Quality Tools - The Histogram	"The researcher is looking at the **shape** of the dataset" [Timestamp: 3:38.5-3:41.7] "Basically, just the **building** blocks of any histogram is the **number** of times that it occurred." [Timestamp: 2:33.7- 2:39.1]
Social and Emotional Benefits of Physical Activity	"For **you** as students, I **always** recommend taking regular study breaks…" [Timestamp: 0:57.5-1:00.7]
Creating relationships in MS-Access Database	"We use this Show Table dialogue box to **add** our tables to our relationship window" [Timestamp: 1:30.2-1:35.9]

Vocal melody is also used to articulate the concept. The table below categorises the screencasts according to a high, medium, or low vocal melody. Screencasts which have a high vocal melody, i.e., the frequency of the voice changes regularly, have a noticeably wider pitch range and the voice is more melodic as a result. A low vocal melody indicates that the frequency of the voice remains relatively constant with little variation in pitch range. Finally, a medium vocal melody points to a variation in pitch range at intervals throughout the screencasts, such as when starting a new topic/slide, yet uses a constant pitch at other points within the screencast.

Table 5:11: Categorising the screencasts into High, Mid, and Low Vocal Melody

High Vocal Melody	Mid Vocal Melody	Low Vocal Melody
Vector 2D Animation	The Seven Quality Tools - The Histogram	Social and Emotional Benefits of Physical Activity
Matter	Introduction to Transformers	Food Allergy and Food Intolerance - what is the difference?
Using Read & Write for Exams	Relational Databases	How to get started in Matlab
Referencing using MS Word		Full Wave Rectification
Calculating Concentrations		Local Area Networks
Microbial Bioplastics		

How to access and use the BNF Online		
The psychological effects of hearing loss on patients		

Some lecturers make use of tempo and tone to mimic the activity on screen, such as in the screencast on Vector 2D Animation. In the first example they use a monotone voice to demonstrate the robotic nature of the bouncing ball, without the principle of 'easing in and out' applied.

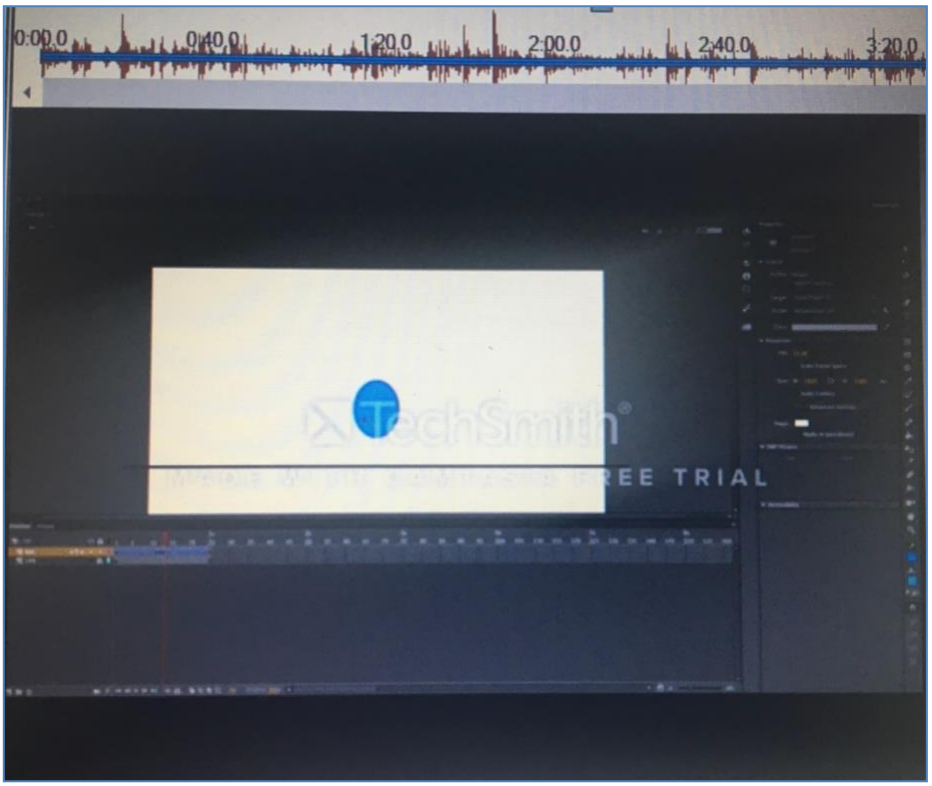


Figure 5:19: Mimicking on-screen activity through voice (waveform) in Vector 2D Animation

[Timestamp: 4:42-4:50] *"As you can see here, it is just moving straight down into the squash and then moving up and down straight back out of the squash"* **(Frank, Design Lecturer).** The underlined text indicates a change in tone and tempo to a more monotone voice to mimic on-screen activity.

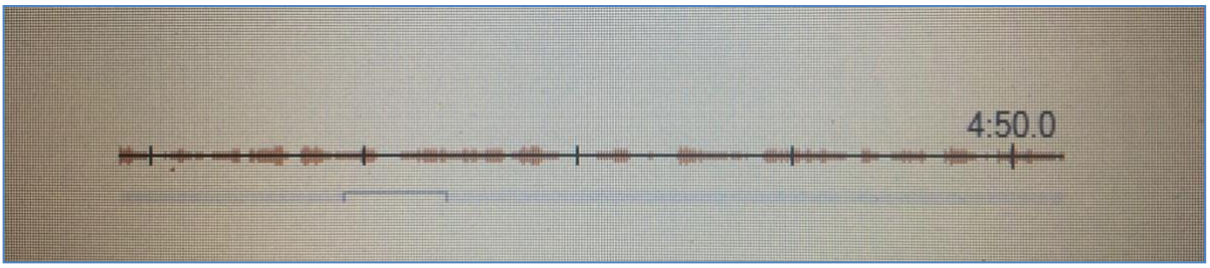


Figure 5:20: Waveform denoting monotone narration (Vector 2D Animation)

Once this point is made, the lecturer reverts to a wider pitch range to continue with the task and explain how to correct the issue. Here, they also use voice tempo, intonation, and repetition to imitate the accelerated timing of the ball, demonstrating the affordances of this mode to teach the concept.

[Timestamp: 5:12-5:20] *"The ball should be **very** close when it's at the bottom, **very very** fast through centre, and then giving us the hang time [inaudible], push those timings at the very very top of the arc"* (Text in bold to indicate emphasis).

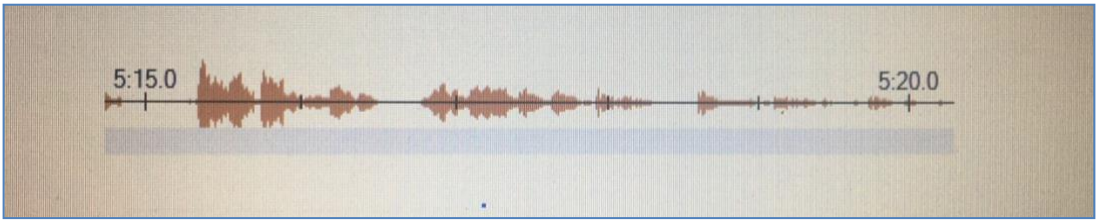


Figure 5:21: Waveform denoting accelerated tempo and tone (Vector 2D Animation)

Discourse Markers

Discourse markers can provide noticeable insight into lecturers' semiotic articulation. I chose to analyse the use of the discourse marker "so", because of its prevalence in the screencasts. Though it could be argued that discourse markers belong in the linguistic mode, I chose to include it here, since it is often used emphatically and as such is a good example of prosody. Adapting Castro's (2009) pragmatic functions of discourse markers as cited in Erten (2014), my analysis focused on the use of 'so' specifically as follows:

Table 5:12: Analysis of the discourse marker "so" in the screencasts

Opening frame marker	To start a topic	[Timestamp 0:25-0:28] *"So, the first thing we need to do…"* (Calculating Concentrations, Joseph, Science Lecturer).

		[Timestamp: 1:10-1:13] *"So, what does the transformer look like on an electrical diagram?"* (Introduction to Transformers, James, Engineering Lecturer).
Closing frame marker	To conclude a topic	[Timestamp: 5:05-5:10] *"So, as you can see, emotional and social well-being as a result of being physically active, they very much co-exist"* (Social and Emotional Benefits of Physical Activity, Sophie, Social Science Lecturer) [Timestamp: 5:58-6:18] *"So, in summary, in this screencast, we have seen…"* (*Creating relationships in MS-Access Database*, Saran, Business Lecturer).
Information indicator	To indicate either new or old information associated with the topic	[Timestamp: 5:07-5:13] *"So, you can insert a placeholder, which means you can come back to it at a later stage"* (*Referencing using MS Word*, Martina, Academic Student Services Support Lecturer). [Timestamp: 1:30-1:34] *"So, the LAN hardware components can be described as follows"* (*Local Area Networks*, Robert, Business Lecturer).

Structural marker / Referential marker indicating causality	To mark structural hierarchy / causality in explanation of concept, i.e., this happened, so this follows…	[Timestamp: 3:56- 4:00] *"So, if we use a dropdown menu, it will show us where we are"* (*Getting started in Matlab*, Conor, Engineering Lecturer). [Timestamp: 3:32-3:36] "So, let's look at some examples of that on the following slides"
		(*The Seven Quality Tools - The Histogram*, Paul, Business Lecturer).
To invite reflection / engagement / interaction		[Timestamp: 3:23-3:33] *"So, if we look at the positive half cycle, so if this end is positive with respect to this end, which two diodes are going to conduct?"* (*Full Wave Rectification*, Brenda, Engineering Lecturer).

Music

The music included in these educational screencasts has quite a specific purpose: either to keep the viewer's attention or to evoke an emotional reaction. Two screencasts used an external video with a soundtrack. For each piece of music, there is either an explicit or implicit connection with the content of the screencast, in terms of the lyrics chosen. Tempo and tone vary from fast and loud in one screencast *(What is plagiarism?)* to calm and soft in the second example (*Psychological Effects of Hearing Loss).* In addition, there is evidence of musical perspective, as the music is foregrounded in the former, while it alternates between foreground and background in the latter. Music with lyrics is included in the first as the main carrier of meaning, while a combination of music/ lyrics and instrumental pieces are included in the second piece, revealing a hierarchy of voice, music with lyrics, and finally music in terms of meaning-making potential. In the first screencast above, the music was included because *"it sort of prompted more attention"* (**Martina, Academic Student Services Support Lecturer**). In the second screencast the purpose is to evoke an emotional connection with the viewer making it *"a bit more real., […] the actual audio of it emphasises what she's missing"* (**Joanne, Health Science Lecturer**). This screencast

was chosen for more detailed analysis in the next section and a further discussion on the role of music is included.

The analysis of the aural mode, and in particular the voice, shows the intentionality of the lecturer in their teaching through the explicit use of prosodic features. However, it also reveals the unconscious semiotic choices about how the concept is presented through discourse markers and the positioning of music.

5.9. Understanding the Screencast as a Multimodal Ensemble: Spatial-Design Mode

In this section the focus shifts to the enactment of software features by lecturers to teach disciplinary concepts. Digital literacy and degrees of digital fluency were evident both in the use of presentation and screen casting technologies by lecturers, and in their knowledge of instructional/universal design principles.

Enactment of software features for teaching and learning

For the most part participants used PowerPoint to structure the content for their learners. The table below shows the breakdown of PowerPoint use amongst the screencasts.

Table 5:13: Breakdown of PowerPoint use amongst participants

Discipline Area	Full presentation	Bookend (1-3 slides to show Title or Learning Outcomes)	No PowerPoint used	Mean number of slides used within the discipline
Engineering	19% *(n=3)*	13% *(n=2)*	0	7.8
Science	31% *(n=5)*	0	0	7.4
Business	19% *(n=3)*	6% *(n=1)*	0	9.5
Student Academic Support Services	0	6% *(n=1)*	6% *(n=1)*	1
Total	11	4	1	

Universal design principles

A focus on making digital resources more accessible is evident in the design of many of the screencasts, with some participants demonstrating knowledge of universal design principles and/or instructional design principles in the design of their PowerPoint presentations. Universal Design considerations were evident from the use of the more accessible Sans Serif font, which was adopted for text in 81% (*n=13*) of cases, with 13% (*n=2*) using a Serif font for headings and a Sans Serif font for body text. 69% (*n=11*) of participants chose a suitable background colour for the presentation slides, ranging from pale blue to pale yellow.

Accessibility

During the qualitative interviews, it emerged that some participants had included accessibility considerations as part of their learning design process.

Paul, Business Lecturer:

"The background is, again, it's a pastel. It's a, it's a kind of a, like, light/bluey grey and again, that's for accessibility."

Martina, Academic Student Services Lecturer:

"In explaining the concept, taking it for those particular students. So, they were second language users, they were here for a very short time, they were doing quite a complex topic of education through English, which was not their first language. So, I would put on my UDL hat. And when I was putting resources on to Moodle, I wanted to give them multiple formats[...] ".

Multimedia Learning Design

Multimedia and instructional design principles were referenced specifically by two lecturers to explain their PowerPoint structure, while the lecturer below enacted a TPACK approach to screencast design, which includes a focus on the use of technology to structure content to facilitate learning.

James, Engineering Lecturer:

"One thing that I thought was important, on that slide was the zoom function that I zoomed in on what I was talking about there. And I was thinking of Richard Meyer when he talked about extraneous content on slides and extra stuff. And is there a need for this content? I know in this context I zoomed in; I think there is a need for the stuff,

but I zoomed in. So, the student could focus exactly on what I was talking about. And you know, you can relate to cognitive load then as well, you know, process what's just there. But I thought that was important on that slide."

However, spatial sequencing and the structure of content within the screencast was often hampered by a digital skills deficit, as outlined by the lecturer below.

Sandra, Engineering Lecturer:

"I struggled at the beginning. I suppose I was completely new to screencasts. Em, I didn't mind screen cast (reference to Screencastomatic™) so much. Camtasia™, I ***definitely*** *(emphasis in original) struggled with, just the different I suppose just the different tools that it had but I suppose practice makes perfect".*

Proof of how digital literacy and fluency can impact the design of digital resources was evident as participants who were comfortable with the software could explore the functionality of the tool and experiment with the design of the screencast, such as Sophie below:

Sophie, Social Science Lecturer:

"I found Camtasia really interesting to work with, because the fact that you could separate the audio, and, you know, it was a lot more malleable, say than Screencastomatic, which is basically just recording a voiceover presentation. Ehm, so I'd a lot of fun working with that, and just, you know, being able to be more creative with it, I suppose, and bringing in bits and pieces."

In a number of cases, lecturers linked the affordances of the digital technologies to the potential for learning. For screencasts that provide a walkthrough of software, where the lecturer has no control over the positioning of elements within the software, the use of a Zoom and Pan tool draws attention to parts of the screen, providing the lecturer with opportunities for spatial sequencing. Analysis of the screencasts show that 63% (*n=10*) of participants used the Zoom and Pan tool to focus the viewers' attention on a particular part of the screen. Equally the positioning of elements on the slide was deliberate to assist learners with cognitive processing.

Temporal sequencing is evident in the way the information is presented to the viewer. PowerPoint animation is used frequently to present information relating to the concept incrementally. The table below provides an overview of the enactment of software features across all 16 screencasts. A large proportion (69%, *n=11*) used PowerPoint

animations to present content on the slides, while 75% (*n=12*) used the cursor (either with or without the addition of a highlighter available in Camtasia™) to draw attention to elements within photographs, illustrations, or the text content on the slides. Some participants considered the spatial / temporal sequencing choices they made and offered improvements spontaneously:

Sophie, Social Science Lecturer:
"I should have used more animation in them to bring in the words, maybe one by one [why] I think there was just too much text coming in at one time."

It was evident that lecturers had used a range of digital skills to design the screencast, employing a combination of modes. These modes function as semiotic signs, both individually and collectively, where the multimodal nature of the screencast provides opportunities for transmediation and transduction. The following section presents examples of the interconnectedness of modes and the lecturers' perception of the multimodal meaning-making potential of the combination of modes.

5.10. Major and Minor Modal Carriers of Screencast Content Meaning

It was evident from the qualitative interview data that participants value the use of some modes over others in their teaching. In choosing the modes they feel best represents the concepts they wish to teach, lecturers establish meaning from their own epistemological engagement with the world and the academic community to which they belong. While many of them come from a monomodal (logocentric) tradition, there is demonstrable recognition of the potential of other modes to be major carriers of meaning, as Joseph highlights:
Joseph, Science Lecturer:

*"I thought from an emphasis point of view that **if I just said** [lecturer emphasis], you weigh out, and you add, and you do, yeah, I mean, I think a chunk of students will get that. But I also think that **if I include the pictures** [lecturer emphasis], I'm not upsetting the students who get the words, but I'm helping the ones who don't, I think."*

In some cases, the lecturers indicate a preference for the graphic pictorial / aural mode rather than the linguistic mode (as presented in this thesis):
Aoife, Science Lecturer:

*"They're **listening** [lecturer emphasis], And, you know, **they're looking at images***

[lecturer emphasis], and they're listening to what you're saying, because I'm always bringing in stuff to read. And I find the most resistance to that, rather than talking about something or, like showing them a video […]".

Participants were also asked to identify the mode or modes they felt were the major or minor carriers of meaning. The table below lists the modes in order of importance, with the first mode identified as the major carrier of meaning. Where a mode was not mentioned it was omitted from the table. However, this is not to say that the mode was not used within the screencast, merely that the lecturer did not refer to it during the discussion.

Table 5:14: Major / Minor Carriers of Meaning

Discipline	Concept presented in screencast	Major Carrier(s) of Meaning	Minor Carrier(s) of Meaning
Engineering	How to get started in Matlab	Visual - Screenview, Voice	Text
Engineering	Matter	Visual	Voice, Text
Engineering	Full Wave Rectification	Voice	Text, Visual
Engineering	Introduction to Transformers	Voice, Spatial - Design (Zoom, cursor)	Visual, Text
Life Sciences	Calculating Concentrations	Voice, Text	Visual (but only if the question was phrased differently)
Life Sciences	Microbial Bioplastics	Visual, Voice	Text
Life Sciences	How to access and use the BNF Online	Voice, Visual	Spatial - Design (Powerpoint Slides, Bullet points)
Health Sciences	The psychological effects of hearing loss on patients	Visual, Spatial - Design (Call outs)	Voice

Social Sciences	Social & Emotional Benefits of Physical Activity	Voice, Visual	Text
Creative Media	Vector 2D animation	Visual, Voice	Spatial - Design (Cursor)
Business	Local Area Networks	Voice	Text, Visual
Business	The Seven Quality Tools – The Histogram	Voice, Visual, Spatial - Design	Text
Student Support Services	Referencing using MS Word	Voice	Visual - Screenview, Spatial - Design
Student Support Services	Using Read & Write for exams	Voice, Visual - Screenview	--
Hospitality	Food allergy and food intolerance – what is the difference?	Visual, Voice	Text
Hospitality	Creating relationships in MS-Access Database	Visual, Voice	Text

Graphic-pictorial and aural modes were the most commonly cited modes used as either a major or minor carrier of meaning and were included in all screencasts. However, the graphic-pictorial mode carried most of the functional load in 44% (*n=7)* of the screencasts, while the aural mode (specifically voice) was deemed the most important mode in terms of teaching the concept by 50% (*n=8*) of participants.

Interestingly, spatial-design features, i.e., software features such as Bullet Pointing, Animation (PowerPoint) and Use of a Cursor, Zoom and Pan (Screencasting Software) were included as major carriers of meaning in 19% (*n=3*) of the screencasts. These features were also listed by 19% (*n=3*) of participants as minor carriers of meaning. Graphic-pictorial and aural (voice) were included as semiotic companions in 56% (*n=9*) of the screencasts. Text was mentioned as a major carrier of meaning in only 6% (*n=1*) of screencasts, though it was preceded by aural (voice). However, text was considered as a minor carrier of meaning by 63% (*n=10*) of participants.

There was considerable reflection on the value of the intersemiotic relationship between modes used to present the concept during the qualitative interview:

Conor, Engineering Lecturer:

"It's a lot more comprehensive (to include multiple modes), I think. […] If you were to rely just on, if you were to take out the sound and rely just on the visual and the text,[…], I think it would disrupt the whole screen cast a bit more because even obviously you need to give time to read, you'd be changing the emphasis from what they see on the screen to direct them towards what you want them to read and go back to screen. Whereas, when there's ***voice*** *[lecturer emphasis], you can focus on what you're particularly trying to* ***show on the screen*** *[lecturer emphasis] and then listen to what you're, you're trying to get across as well."*

Participants were quite aware of how each mode brings a new semiotic dimension to the learning process. Yet, as meaning making is translated across modes, transduction occurs. Within the screencast, where transduction takes place simultaneously e.g., images and words (spoken or written) are presented side by side, this transmodal moment is semiotically rich in meaning.

Brenda, Engineering Lecturer:

"All three things are telling you the same thing, pretty much. It's just doing it in different ways. And hopefully, that one of them will click with them. And that it will, it will make sense."

Equally, they recognised the value of the combination of modes in presenting the concept to their students and contested that leaving out one of the modes could be counterproductive. In most cases, the screencast combines all four modes included above, i.e., graphic- pictorial, aural, linguistic, and spatial-design modes and participants argued that each mode had a role to play in the explanation of the concept.

Robert, Business Lecturer:

"I think it's diminished or compromised by the absence of one [mode]. You could get by. But you have a richer experience I think by all three. I wouldn't like to be without any one of my senses."

During the qualitative interview participants had an opportunity to consider transduction within their screencast, through the Inquiry Graphics analysis activity. They noted the

semiotic change during the process and reflected on whether they would include the same resources now, were they to create the screencast again:

Martina, Academic Student Services Support Lecturer:

"My key thing was to use the tool, and then those incidental things came up. So too, I always think that students should know why they're doing something. And so that was what I put in there. But looking at it now, I think probably I should have used words as well, to emphasize it maybe a little bit more. But the downside of that is there's so much speech going on, would they have noticed it?"

Brenda, Engineering Lecturer:

"[…] now that I'd look at it in detail. And I would not have noticed this before. That's obviously like a two pin, which would be more representative of the US, so it's obviously a US generated image."

This reflection was an important element of the Inquiry Graphics (IG) analysis activity completed during the qualitative interview. Lecturers reflected on their semiotic choices and considered these in the context of the message they wished to communicate within the screencast. The section below presents an overview of the IG analysis activity carried out for a key moment of learning within the screencasts.

5.11. Inquiry Graphics (IG): Unpacking the visual elements to understand the screencast lecture goals

From the participants' choice of key moments, I selected one for the IG analysis, based on a preliminary scoping analysis of the screencast, where I noted specific multimodal key frames. In most cases, at least one of these frames overlapped with the key moments identified by the participant.

Participants were provided with a short explanation of the process before undertaking the IG analysis. Each of the following sections examines lecturers' engagement with this analysis.

1. Phase 1: Representamen

This initial stage of the IG analysis considered the representation of the key moment, i.e., the PowerPoint slide as a graphic, comprising text and graphic-pictorial representation, and challenged participants to list all elements on the screen. They found it difficult to 'step backwards' and could only describe the elements within the context of their discipline.

Commenting on the challenges they faced, one lecturer notes:
Joseph, Science Lecturer:

"So yeah, so you're more shapes than what it is – difficult for me to see it. Imagine I look at it and I think, like, I don't even see it as a shape."

Some participants immediately explained their design, moving immediately to Phase 2 of the IG activity. Concentrating on specific elements encouraged the lecturer to consider why they chose these to represent the concept.
Robert, Business Lecturer:

"It's just a simple monochrome graphic, various shades of white, black, and grey. Again, for simplicity and clarity. Just easy, easier to interpret. It was a fairly clean graphic as well. The font is well defined. It's quite easy to make out what's there. So, we've got a few different images describing ehm we've got like images of PCs, a server, and printers."

Finally, one participant compared the IG Representamen activity with his effort to reduce visual noise for students, especially those with additional needs. Focusing on individual elements on the screen helped him to understand that there may sometimes be too many things in the screencast, what he calls "visual noise".
Frank, Engineering Lecturer:

"It's funny you say that because […] this is what I was talking about, that I am aware […] this particular thing can be extremely overwhelming and can be kind of a trigger event where it causes huge amount of stress. So, it's about paring this back for visual noise, ehm just true language and interactability and that's why I'm not focusing on using tools and […] I'm just saying click and drag them and right click, I'm not saying you know, I'm not describing everything on the screen because I'm aware of how noisy it is."

2. Phase 2: Interpretant - Denotation

During this second phase of the IG activity, participants were invited to expand on the list of elements they had noted, to include a basic description of the nouns. Again, evidence of disciplinary knowledge surfaced within the descriptions, demonstrating how naturally embedded in the disciplines some lecturers were.

Conor, Engineering Lecturer:

"So, the basic description was that it was a layout of the user interface with three main areas. Ehm, together with command ribbon and desktop Taskbar and the areas then are named as command window, command history and workspace or current directory."

This reflective activity also prompted some participants to comment on the characteristics of the elements they had included and to which they previously hadn't given much thought. From a teaching perspective, they realised that they were communicating a message which they hadn't necessarily intended to communicate.

Sandra, Engineering Lecturer:

"[…] now that I'd look at it in detail. And I would not have noticed this before. That's obviously like a two pin, which would be more representative of the US, so it's obviously a US generated image."

Some participants felt they needed to remove themselves from the discipline altogether to be able to 'see' the elements on the screen, yet examples of disciplinary knowledge still come through in their denotation (description):

Robert, Business Lecturer:

"Ehm, so I'm trying to put myself in my mother's shoes, I suppose. Ehm, so I'm seeing little televisions and little boxes connected with black wires to another little box that's connected to a bigger box, and something that looks like a printer, and then a cloud with it with a lightning bolt."

The IG analysis framework provided an opportunity to explore the semiotic exchange that occurs when semiotic resources are interpreted within different social contexts.

3. Phase 2: Interpretant - Connotation

The second part of the Interpretant phase included the Connotation activity, i.e., participants were asked 'what does this mean?' In other words, having listed the nouns that you see on screen (Representamen), and provided a basic description of these (Interpretant- Denotation), can you tell me what this means in the context of the discipline? The participants were visibly more comfortable during this activity, because

it allowed them to revert to their disciplinary persona and use the language of their discipline. The hesitation notable within the first two parts of the activity by the significant number of pauses and discourse markers (okay, um), was replaced by a confidence that demonstrated they were back on familiar ground, evidenced by the ease with which they answered the question:

James, Engineering Lecturer:

"That shows the core the primary winding and the secondary winding, which are the first three lines of text. And then the idea of the photograph on the bottom right is the enclosure."

5.11.1. Phase 3: (Research) Object

The final part of the IG activity relates to the research aim of this study. Here again, participants were much more at ease explaining how it should help students increase their knowledge:

Fiona, Academic Support Lecturer:

"So, I suppose in addition to using this for their exams, hopefully, they'll go away, and it goes back to that thing that it gives them independence. So, and I'll often see this, I see students all the way through first year or maybe semester one a lot in first year, and I'll never see them again, until the graduation day when they're literally coming back in going, Oh, that's great, thanks a million […]"

It was evident from the IG analysis that many participants were deeply embedded within their disciplines and had difficulty in stepping back from their disciplinary expertise, to consider how the semiotic resource might be interpreted in any number of ways by students within a different sociocultural context. These lecturers reflect on the alternative possible interpretations of elements within their screencast:

Martina, Academic Support Lecturer:

"It sort of goes back to the, you know, if you think about those war movies and things, where they're parading through the streets and the pride of you know, you've done great for your country, they've got no relevance to (this) other than somebody is being congratulated because they've done they've done something, and that's probably the connotation, and I had written down pride in doing the right thing, and then the congratulations of the person or the […] applause or the action of applauding […]"

Sandra, Engineering Lecturer:

"The more you analyse that picture, is it is it a good image to use? After all you're, like you're [referring to me] really going into detail. Like whereas to me, I picked an image that I thought very quickly, you can see here, you've AC and then we want the DC to power our computer or whatever. But, in hindsight, this by itself, may have been better for students."

The IG analysis provided an opportunity for lecturers to consider the meaning-making potential of their semiotic choices, embodied in the modes they used and how these were arranged. It also revealed potentially inappropriate interpretations, which were not considered at the design stage of the screencast, but which lecturers acknowledged could have an impact on students' engagement with and understanding of the concept they were trying to teach.

In this chapter I used the MMI to examine the screencasts for insights into lecturers' semiotic choices, across a range of disciplines. The following chapter will examine three of these screencasts in greater detail.

Chapter 6: The Multimodal Inquiry (MMI) Framework: Exploring semiotic choices and meaning-making potential in the screencast lecture

In this chapter, the proposed multimodal inquiry framework, introduced in Chapter 2, will be used to analyse three selected screencasts. Background information on the author of each screencast will be included to situate the creation of the multimodal semiotic resource within a sociocultural context and provide an insight into the sociocultural practices of the lecturer and the situated context which might influence their semiotic choices. For convenience, the multimodal inquiry framework is included again below:

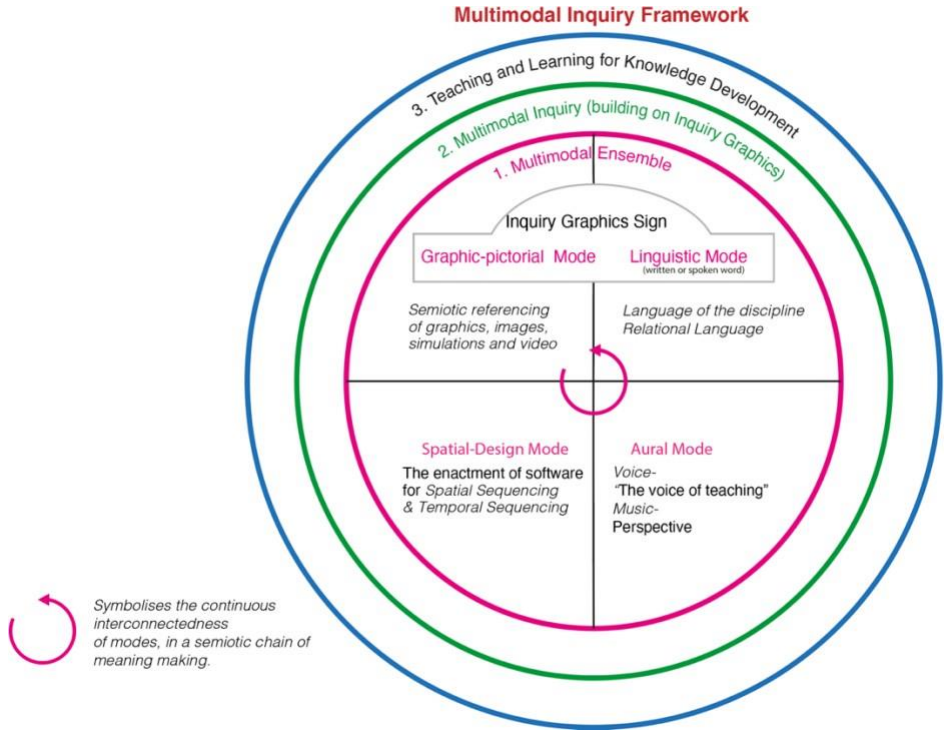


Figure 6:1: The multimodal inquiry (MMI) framework

The screencasts were imported into Adobe Premier Pro and each frame saved as an image to create a collage. Within the PowerPoint presentations each frame corresponds to a slide or part of a slide with zoom-in applied; where there are external videos, frames are chosen when there is a clear change in focus. The section begins with the Inquiry Graphics analysis activity, which was completed with the lecturer during the qualitative interview. Here, the Inquiry Graphics framework is used initially to investigate the use of graphics as representations of conceptual knowledge and is then extended to the use of other modes within the screencast. This focus on inquiry corresponds to the second layer of the MMI framework and supports the argument that a multimodal inquiry framework could be used for critical inquiry. Consideration of

transduction and / or transmediation is also included where this is evident. The next phase of analysis zooms out to the entire screencast and considers how these modes are combined to teach the concept, implementing Layer three of the MMI framework. I argue that this detailed analysis, together with the findings presented earlier in this chapter, will demonstrate the value of a multimodal inquiry tool for critical analysis to examine lecturers' semiotic choices in the production of the multimodal screencast for conceptual knowledge development.

6.1. Screencast #1: Food Allergies and Food Intolerances (Patrick)

At the time of data collection, the creator of this screencast had seven years' teaching experience within the Hospitality discipline area. The screencast uses a combination of PowerPoint slides and an embedded external video to explain the conceptual differences between food allergies and food intolerances to students within the hospitality sector. The collection of thumbnails below represents the slides or frames within the screencast. Each thumbnail captures the information presented at that moment in time. Some of the thumbnails are repeated with additional elements included, such as zoom, highlighter, etc. Thumbnails from the external video represent each frame within the video. Yellow square brackets indicate the beginning and end of the external video.

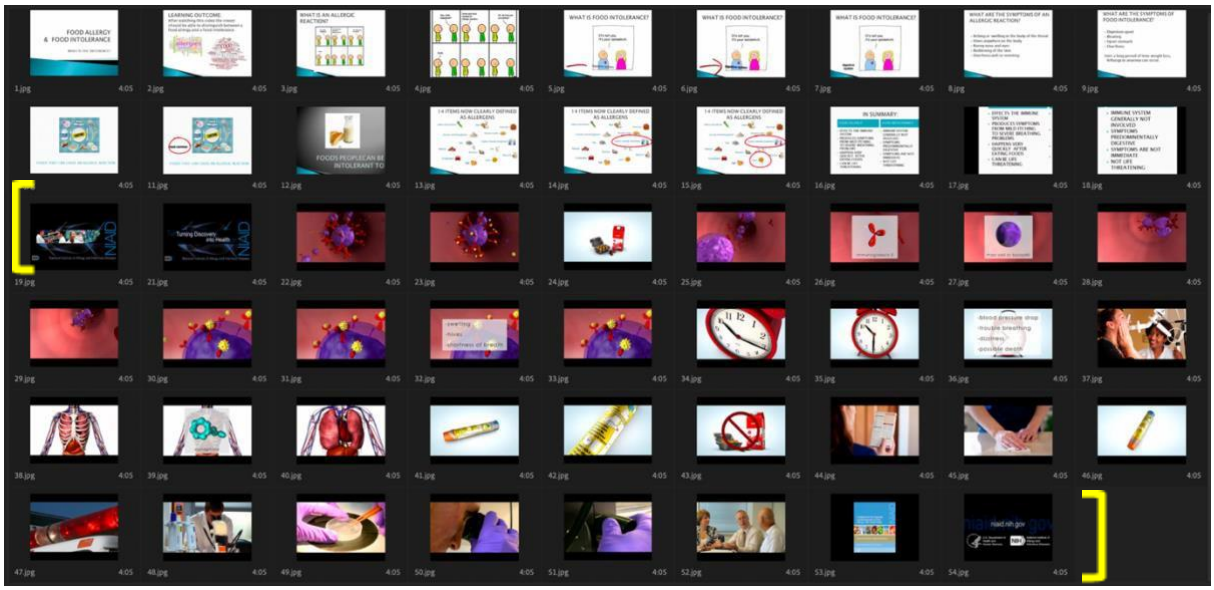


Figure 6:2: Visual composition of screencast #1

6.1.1. Inquiry Graphics Analysis

To interrogate the multimodal digital artefact further using Inquiry Graphics, one of the key moments (KM) from Patrick's list was selected. Since he placed considerable emphasis on the importance of knowing the 14 allergens, and there were four modes

present (graphic- pictorial, linguistic, aural, spatial-design), I chose a KM that presented the 14 allergens for the IG analysis.

This slide “provides a semiotic account” (Hallewell & Lacković, 2017, p. 1172) of the illustrations’ concept-related message. Simple illustrations are used to represent the concept articulated by Patrick. However, the name of each allergen is added as text on the slide and spatially positioned adjacent to the illustrations, to anchor the meaning of the pictorial representation. In this instance Patrick also names the most common allergens, moving the cursor over each illustration to name the allergen. All 4 modes are combined to provide a semiotic account of the concept:

- Graphic-Pictorial: Illustrations provide a visual representation of the concept.
- Linguistic: Text on slides (Patrick also provides alternative terminology in his narrative).
- Aural: Use of communicative competence to further explain the concept through lecturer narration and the embedded video.
- Spatial-Design: Spatial and temporal sequencing, digital fluency (choosing the right tools, e.g., PowerPoint cursor tool), and digital literacy (using the digital tools proficiently, e.g., screencasting software highlight tool).

The following table presents a synopsis of the IG analysis activity completed by the lecturer. Each numbered column within the table corresponds to a phase within the IG approach and I use the research questions for this study as the focus of the Research Object

Figure 6:3: Key Moment [Timestamp: ~3:50- 4:15]

Table 6:1: A synopsis of the IG analysis activity

1.Representamen List what you see / hear (key words) on the screen	**2.Interpretant**- Describe what you see/hear		**Speech-** Transcript from screencast	**Research Object**- What does this image mean in this research context?
	Denotation - (basic description)	**Connotation-** what does this mean?		How does this image connect to content knowledge? How does the image help learners learn about allergens?
"Heading *Pictures* *Images* *Writing* *Highlighted items* *All food-related titles"*	*"They're photographs […] taken from something"*	*"The heading is self-explanatory of what it is"* *"Anything I would have used there would have been, because it says 14 and Ireland is the only country saying 14, so it must have been something very close to reality."*	*"In 2014 Leo Varadkar the then Minister for Health passed a law. These 14 items, which are specifically under EU law, clearly have to be labelled on menus are the most common forms of allergens in this country. This law is being enforced through environmental health officers under contract with the FSAI. Most of these items we know already: shellfish, peanuts, fish, gluten, sesame seeds, tree nuts, but items such as sulphites which are preservatives in foods, and lupin which are a nut extract are not so common. So now people when they go into these restaurants and look on menus, they can see the list clearly labelled and what items are in what dishes".*	*It's "a very important list you need to know, they're all on the one page […] to make it easier for you to understand them, make it easier for you to remember […] them".*

The following section provides a more detailed account of the Inquiry Graphics analysis, using interview quotes and screencast data to illustrate the points made.

When asked to list the **Representamen,** Patrick explained what he did: "*so I've just written it down I'm looking at the screen now just as a person that's looking at it for the first time."* Following a discussion about further deconstructing the elements, he clarified his understanding:

"So, like you're just, you're just stripping it right back. Instead of like the red thing, I just knew that was a highlighter no matter what was on that screen I would have known that was a highlighter, but you went back and went just something with a red circle- going back, really back before that again."

The **Denotation** phase required the lecturer to describe what they saw in basic terms. Patrick describes the slide as *"busy"*, noting *'they're photographs […] taken from something."* The importance of the graphic-pictorial mode is highlighted: *"if my voice was never on that I think the visuals are a given […] I think anything you can give them that they can see."*

Extending the IG analysis to include the aural mode within the MMI framework, he was asked to comment on his use of voice. He noted:

"I suppose I'd say I was reading too much off a script for it that should have flowed a bit more freely as regards to that".

Following this commentary, Patrick moves away from describing or interpreting the narrative style accompanying the visual, to discussing the conversational style used normally in his teaching. Acknowledging that he was *"new to screencasts"* when he created this screencast, he would *"definitely be doing it a lot more differently"* now, aiming for *"the same way you kind of flow […] when you're standing in front of the students and talking, you know?"* Finally, the screencast included spatial-design decisions to enhance meaning through the use of the Camtasia highlighter which focused on two less common allergens, *"you'd definitely have to explain two, you'd have to come down to the lupin and the sulphur dioxide […] some of them are self-explanatory, maybe some not so much."*

6.1.2. Interconnected Modes in this KM

The graphic-pictorial mode alone would not be sufficient to represent the 14 allergens and could cause confusion for the students because of the potential for multiple interpretations of these generic pictorial representations. The addition of the text provides the necessary semiotic anchorage for the students, while Patrick also situates

the elements through an accompanying narrative within the learners' social semiotic context, e.g., references to the Irish Health Minister who introduced this legislation, the agency responsible for the enforcement of this law; the 'commonness' of most items on the list in the students' environment; and the situated nature of the allergens, when *"people go into these restaurants, they can see what items are in what dishes".* This demonstrates how meaning is enhanced when combined with another mode, whether this is intentional or not.

The IG analysis assisted Patrick in uncovering the semiotic decisions he made to represent the conceptual knowledge he wanted to teach during one key moment within his screencast. Following this, I wanted to zoom out and examine the screencast from a holistic perspective, using the MMI framework to explore other semiotic choices.

6.1.3. Multimodal Inquiry: An Overview

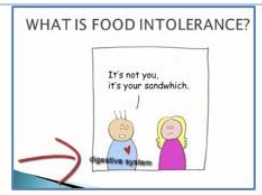
I move now to view the screencast as a multimodal whole, which allows me to explore which modes carry the functional load as the main carriers of meaning. Additionally, I examine the potential for meaning making and multiplicity of interpretations through the combination of modes. To do this I use an iterative zoom-in/zoom out approach, zooming in at each iteration to focus on one mode, then zooming out to see how this mode contributed to the overall conceptual knowledge presented in the screencast.

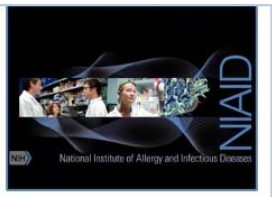
Graphic-Pictorial Mode

The graphic-pictorial elements are listed below as they appear chronologically within the screencast. The key moment that was the focus of the IG analysis activity above is included for completeness but is not the subject of analysis in this section. The use of semiotic referencing as an analytical tool reveals the importance attributed to the graphic-pictorial elements within the context of explaining/teaching the concept in this screencast.

Table 6:2: Graphic-pictorial elements in screencast #1

Categorisation / Modal Element	Semiotic Referencing in Lecturer's Narration	Description / Comments	Image
1. Text as Image	Unprobed Representation: Attentional	Two word clouds on one slide. On the left, the main word is 'allergies' on the right the main words	

		are 'food' and 'intolerance.	
2. Image – Illustration	Unprobed Representation: Depictional	Comic Strip- 6 panels with 2 characters. One has a bump on the nose. Accompanying text includes play on words 'swell'.	
3. Image – Illustration	Unprobed Representation- Depictional	Two characters. Accompanying text includes reference to well-known phrase *'it's not you, it's me'*, changed to *'it's not you, it's your sandwhich'* (sic).	
4. Image-Illustration	Semiotic Articulation Lecturer uses cursor to refer to specific allergies as he talks about them.	Food allergies: includes clipart of common food allergies.	
5. Image –Photo: Iconic-conventional depiction of concept (bread and milk)	Unprobed representation- Depictional	Photograph of milk in a bottle and white bread.	
6. Image-Illustration	Semiotic Articulation- Lecturer uses cursor to point to less well-known allergens, e.g., lupin.	Clipart of 14 allergens	

7. External video	Unprobed representation-Depictional	Video from American National Institute of Allergy and Infectious Diseases.	

Most of the images used by Patrick fall into the category of illustrations, either in comic art form or simple illustrations. Of the seven graphic-pictorial elements identified within the screencast, four were categorised as “Unprobed Representation - Depictional”, i.e., the graphic-pictorial elements are present in Patrick’s explanation, yet he does not make any explicit reference to the elements visible at that point. Two of these elements may be categorised as comic art, providing an alternative semiotic account of the concept presented.

While the graphic text (word clouds) is representational in terms of the concepts being presented, it has a purely attentional function. For the final two graphic-pictorial elements analysed within the screencast, Patrick’s explanation articulates the features of the illustrations.

Transduction

While the use of multiple modes can help with understanding, there is also the potential for confusion if care is not taken to align the intended message. In this screencast one such example exists at 2:56 minutes, where conflicting messages are communicated and the potential for cognitive dissonance increases. The text *“most common”* is spatially situated beside a pictorial representation of the 14 most common allergens. However, the temporal sequencing is out of sync as Patrick says, *“most are very very very rare”,* referring to the next point in his explanation of the concept. This underlines the importance of considering the interconnectedness of modes and their potential combined meaning making.

Finally, the addition of the external video reinforces the intended message and gives additional weight to Patrick’s own screencast. During the interview he further explains: *“so it kind of makes it more clear. Even that 2-minute video kind of goes a little bit deeper saying this is what happens to the system, this is what you need to do…”*

The graphic-pictorial elements within this screencast are varied but although they are primarily unexplained representations within the screencast lecture, Patrick considers the visuals a key semiotic vehicle: *“if my voice was never on that (screencast), I think the visuals are a given”*.

Linguistic Mode

The target audience for this screencast is learners within the Hospitality sector, specifically apprentices, and the concept is presented through the semiotic lens of a lecturer who has a dual role as a professional working in the industry and a part-time faculty member.

The disciplinary language used within the screencast contributes to the conceptualisation of knowledge. Patrick provides an example of what happens *"when people go into the restaurant, they can see what items have what allergens",* applying the learning from the screencast in the real world.

Disciplinary acronyms such as HACCP (Hazard Analysis Critical Control Points), FSAI (Food Safety Authority of Ireland), EHO (Environmental Health Officer) are part of Patrick's vocabulary used within the screencast and in the interview without explanation (unless prompted). He suggests that *"anybody that has any interest in going down a food line should know all of those acronyms"*, that these should become part of their vocabulary. Additionally, medical concepts such as anaemia, Crohn's disease and irritable bowel syndrome are included within Patrick's presentation, but not explained. Within the external video, terms such as immunoglobulin, mast cells and basophils and epinephrine are introduced and represented visually, but with no further explanation. The student will need to absorb these terms into their disciplinary vocabulary, through association with the core concept presented here.

Patrick explains the difference between food allergy and food intolerance *"because there's a lot of confusion out there."* The rationale for including the science behind the allergies is *"because you'd always get students asking what exactly happens with an allergy […] so that video kind of explains what happens to the system."* As learners progress through their academic programme, they acquire this new language.

Allergens Sulphur Dioxide (Sulphites) and Lupin are explained specifically because they are *"not so common",* while other allergens are simply listed. However, there are some examples of references to the discipline and use of language which is already familiar to the learners, e.g., *"chefs now when planning menus, gluten-free items are as commonplace on these menus as items such as vegetarian"* [Timestamp: 3:41-3:46.2] and the regulations that govern the industry *"these 14 items, which have specifically under EU law clearly have to be labelled on menus under the most common forms of allergens in this country"* [Timestamp: 3:51.7- 4:07.5]. It is assumed by Patrick that the audience for this screencast is familiar with the relevant regulatory bodies.

The teaching approach used to present the concept in this screencast is primarily didactic. Examination of the screencast indicates a lecturer-focused approach, given

the small number of instances where Patrick uses the pronouns "I", "We" or "You", preferring to focus on the content. However, there is some evidence of a relational pedagogy within the screencast, which is further explored during the qualitative interview. Here Patrick explains the importance of connecting with his students: *"I think it suits the people I have in front of me if I'm to be honest. I think, it's kind of just more of a conversation that you're having."* When explaining the assessment for the module, he uses a more student-friendly vocabulary:
"I took out the reflective log part of it and said, look it, we'll call it a food blog. It changes the whole thing. And I said, look it, take a few pictures of work, talk about it, you liked it, you didn't like it. How'd that day go? […]."

He is also quite cognisant of the variance in student ability, *"I've someone 10 years in the kitchen that has no papers, and someone that's 3 months in the kitchen"* and explains that he adapts his teaching to suit *"learning within the learning context. As well as them finding out about this, explain where they would find these ones […]."*
He also considers the physical surroundings to make sure students are comfortable and ready to learn:
"I suppose it's a practical background I'm in, so […] most of the theory, I've to deliver in the kitchen […] I find it works an awful lot better. If I tell them to go and change and go into another room, the batteries come out. […] I think the best I'm going to get out of them is in the kitchen environment. I'm still getting it through to them better, […] than moving out into a classroom surrounding."
The lecturer introduces himself at the start of the screencast and provides information about his current role. Additionally, he thanks the viewers (students) *"for taking the time for (sic) viewing this screencast"*. Beyond this there is little evidence of a relational pedagogy within the screencast. However, during the interview there is a clear sense that Patrick tries to build a relationship with his students, noting *"I think it gets the information to them more clearly rather than the teacher-student mode."* A dialogic approach to teaching emerges from the interview, which contrasts with the screencast, suggesting that while Patrick is comfortable teaching in his familiar physical surroundings, he is not yet comfortable teaching in an online lecture:
"You can start a conversation going […] so if I start a conversation there someone will say 'I know, and I know, that's also in A, B, C and D. […] Or someone else will go, we don't do that anymore […] and it starts a whole conversation."

Aural Mode

Here, the focus is on Patrick's use of voice and music as an additional semiotic mode. This screencast was earlier categorised as having a low vocal melody. While a new slide or new point within a slide provides a prompt for a change in pitch, the voice generally reverts to a more constant/even pitch as the explanation of the concept develops.

Speech characteristics reveal the uniqueness of the lecturer's approach and personality within the design of the screencast. Discourse markers (DM) and speech disfluency reveal the lecturer's communicative intentions. In this screencast, Patrick uses the DM ***'so'*** as a closing frame marker to conclude the explanation of the allergens:

"So now when people when they go into these restaurants, and look on menus, they can see the list clearly labelled and what items are in what dishes" [Timestamp: 4:31-4:38].

Speech disfluency in the form of hesitation markers was quite evident in the screencast at the point between where the lecturer concludes their presentation of the concept and the beginning of the external video (lecturer emphasis is highlighted in bold): *"I've **just** included a two-minute video on food allergy, **just** for the severity of it […]."* It appears Patrick feels he needs to justify the inclusion of the external video to complement the content he provided.

Spatial-Design Mode

Patrick made use of both temporal and spatial sequencing when designing the screencast. On average 4-6 seconds elapse between the presentation of each slide and the beginning of the narration, allowing the viewer a chance to look at the elements on the screen before listening to the narration which contextualises the information. While temporal sequencing can be further facilitated by PowerPoint features such as animation, here the decision was made to present all relevant information at the same time. However, an awareness of the affordances of screencasting software enabled Patrick to draw attention to important elements associated with the concept, as he explains in the interview:

"You could do all your pointing […] if you're zooming in, zooming out, you know the things you can do with Camtasia™: pointing, adding in a video or whatever, and then just come back afterwards, then add in […] the voiceover."

Spatial sequencing and arrangement include both linear and non-linear elements of visual design and reveal the informational value of elements included in the screencasts. The positioning of elements in the illustration below point to Patrick's attempt to focus on the foregrounded pictorial representation first, using a framing device (box) to connect the two food types. The text is positioned beneath the image and used to anchor the meaning, though its prominence relates to the uppercase use of letters to draw attention to the textual reference.

Figure 6:4: Informational value, Salience & Framing

Through the analysis of these spatial design decisions, we get a further insight into the Patrick's pedagogical approach to structuring conceptual knowledge within his discipline. The richness of this multimodal screencast lies in the use of additional modes to anchor the meaning or to situate the conceptual knowledge within a disciplinary and wider sociocultural context. Using a Multimodal Inquiry Framework, which unpacks the screencast from a semiotic perspective, the relationship between the design of the screencast and the lecturer's meaning-making intentions becomes clearer.

6.2. Screencast #2: The Psychological Effects of Hearing Loss (Joanne)

This screencast was created by Joanne, a lecturer within the academic discipline of Health Sciences, who started her teaching career in 2009. The screencast includes the combination of a PowerPoint presentation and an external video. This is embedded within the presentation and book-ended by slides and lecturer narration. Multiple modes are used to represent conceptual knowledge. The following graphic provides an overview of the visual composition of PowerPoint slides and video frames. As before, where a zoom-in approach was used within PowerPoint to focus on one element, these

are included as separate thumbnails. Video frames presented indicate a change in focus. Yellow square brackets denote the beginning and end of the external video.

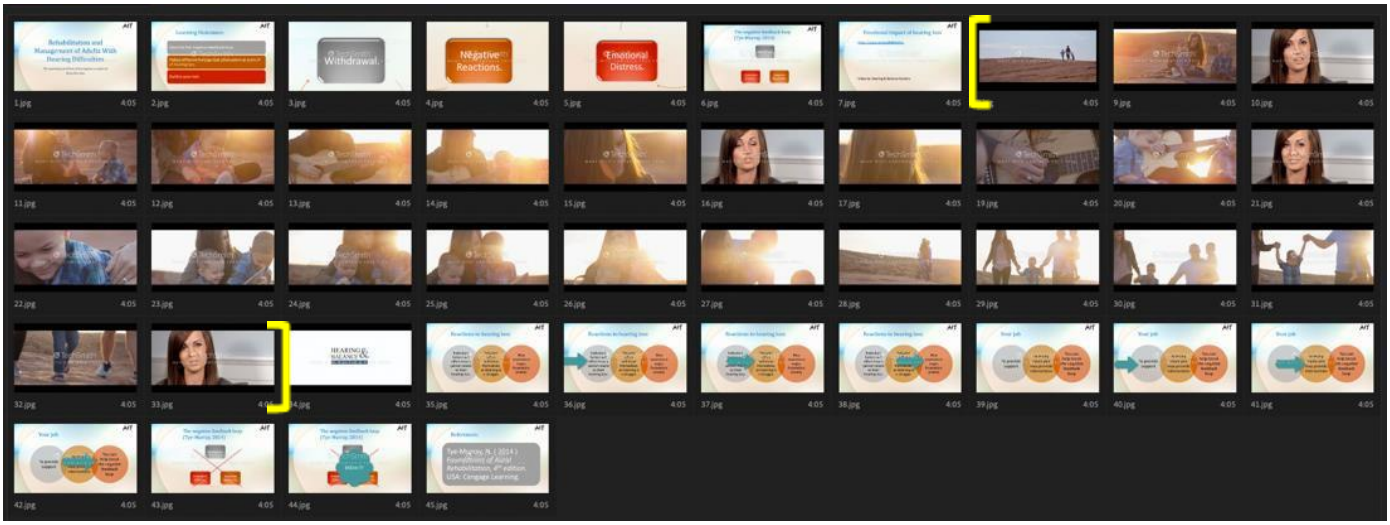


Figure 6:5: Visual composition of screencast #2

6.2.1. Inquiry Graphics Analysis

The key moment chosen for the Inquiry Graphics analysis included all four modes (graphic- pictorial, linguistic, aural and spatial-design). Again, each of the numbered columns in the table below represent a phase of the IG analysis, while the research questions are the focus for the Research Object.

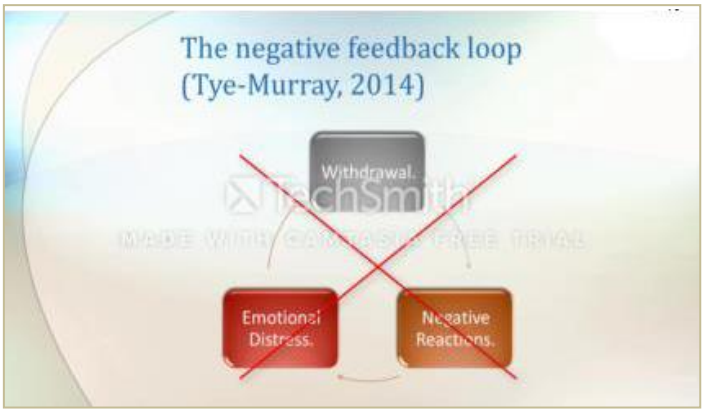


Figure 6:6: Key Moment [Time Stamp: ~5:50-6:32]

Table 6:3: A synopsis of the IG analysis activity

<table>
<tr><td>Representamen- List

What you see /hear (key words) on the screen</td><td colspan="2">Interpretant- Describe what you see/hear</td><td>Speech- Transcript from screencast</td><td>Research Object- what does this mean in this research context?

How does this visual representation connect to content knowledge?

How does this help learners learn about the psychological effects of hearing loss?</td></tr>
<tr><td rowspan="2">Text boxes
A cross
Three arrows
The (HE Institute) logo (removed from slide to preserve anonymity)
Three curves in the background
Various colours:

• Bluey-grey background
• The cross is red
• Blue, brown, red boxes
• The text is blue and white in places
• But the logo is black</td><td>Denotation - (basic description)</td><td>Connotation- what does this mean?</td><td rowspan="2">“You can break that feedback loop. Okay? You can see that negative feedback loop on the screen as a reminder, okay, which we’ve discussed in the session. Withdrawal leads to negative reactions which leads to emotional distress, and it can start at any point, okay? We’ve also discussed, okay, different feelings that might arise, such as anxiety, depression, em, feeling of stress also is another one, many many different feelings which we’ll cover at another stage. But essentially, the key is as an audiologist, you can help to break this negative feedback loop.”</td><td>What we’re trying to do is, this is the process, but we don’t want that process to be completed. We want to intervene, so they don’t end up in this never-ending cycle […] we want to stop it somewhere.”</td></tr>
<tr><td>“The boxes or the rectangles are showing the cycle, so a pattern. The curves and the background are just there to make it visually pleasing. The colours are different for emphasis. So, the title is very clear. So, they remember those words.”</td><td>” I was trying to explain […] the key point that hearing loss causes emotional distress. But students might think, well, okay, there’s not much we can do about that, except give hearing aids, or give, you know, treatments or whatever. That’s not true […]. What they can do is break that negative feedback loop.”</td></tr>
</table>

As before, the use of both interview and screencast data will be used to further explore the Inquiry Graphics analysis. As Joanne listed the **Representamen**, a discussion around the title revealed socio- cultural semiotic interpretations. When challenged about how we can know if text is a title, she replied *"because it's at the top of the page in the title bar. So, which is typical for most presentations. So hopefully, assuming the student knows that…but they may not."*

The IG activity provides the lecturer with an opportunity to explore the underlying assumptions about how their content is presented. Joanne moved immediately into the Interpretant-Denotation phase when listing the elements on screen, providing additional information such as colours to describe what she saw. In her view, the **Connotation** phase revealed the situated nature of the concept:

"what the slide is trying to show. How they can actually, you know, what they can do to help. […] So, what they can do is break that negative feedback loop. […] That's why it's got those arrows […] because they might come in at one point […] they might be able to stop the emotional distress, but they might not be able to stop the negative reactions. But they can help at a certain point. So that's why it's a cyclical process. So, visually, a circle".

In terms of pedagogic value, Joanne felt that it was quite an effective way to help students remember the cycle, *"rather than three bullet points on a slide and me just talking about it. I think you remember that picture"*. The importance of the graphic-pictorial mode was noted several times, with the hope that by trying to use visual tools to explain the concept, it would stay in students' memory for longer. The affordances of the technology also contributed to making the content more memorable and comparisons were drawn between Joanne's own experience as a student where *"just bullet points on a white slide"* were used to present the material and her screencast lecture which uses a variety of PowerPoint and Camtasia features.

Extending the IG analysis to the aural mode, Joanne was asked to comment on the use of the voice. She had quite clearly given considerable thought to the impact of voice on teaching and how this conveyed meaning. While she believed the voice to be quite monotone in certain places, she describes how she uses the intonation and emphasis in her voice to teach: *"I did it on purpose, it wasn't an error. It was really to emphasize, if they don't remember anything else, they're not going to forget that thing."*

6.2.2. Interconnectedness of modes

Joanne was very cognisant of the benefits of using multiple modes within the screencast and explains this in the interview: *"In the screencast I'm visually emphasizing it and I'm verbally emphasizing it by raising my voice."* […] *"They're not going to forget that because visually, there's this big bubble. And also, verbally, there's this big, raised voice from me."* All modes used had a specific semiotic function and according to Joanne, *"the voice, the pictures and the words supplement each other."* When asked about the main carrier of meaning, Joanne pointed to a graphic element, i.e.., *"that big green, whatever it is- the flower or the ball"* (reference to green bubble shape on the second last slide of the presentation). Justifying her design decisions, she shows evidence of socio-emotional competence: *"I teach these people multiple modules, they're probably sick of my voice";* along with an inclusive approach to screencast design, referencing in particular students with visual impairments: *"if […] somebody's visually impaired […] my voice might be more important".*

Finally, to construct meaning in a specific way, Joanne invested considerable time in developing her digital skills. Noting that she watched a video tutorial on how to embed the video because *"[she] couldn't get it in the right bit",* she persevered to ensure that the message communicated was as she intended.

During the Inquiry Graphics analysis, it was evident that reflective practice was a central component of Joanne's teaching, and she engaged critically with the material to explain her choice of mode and composition of the screencast from a teaching perspective.

The following section will zoom out to consider the screencast as a multimodal whole, highlighting examples of the potential for meaning making as embodied within and across modes.

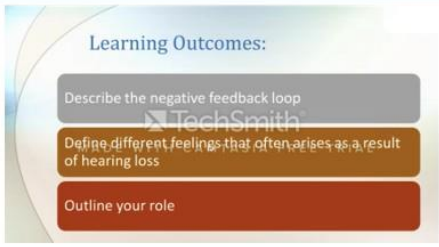
6.2.3. Multimodal Inquiry

Here, I explore how the affordances of each mode are used to teach the concept. Again, I include the key moment discussed above, for completeness.

Graphic-Pictorial Mode

The graphic-pictorial elements are listed below as they appear chronologically within the screencast

Table 6:4: Graphic-pictorial elements in screencast #2

Categorisation / Modal Element	Semiotic Referencing in Lecturer's Narration	Description/ Comments	Graphic
Graphic with Text	Unprobed representation-depictional. Learning Outcomes are repeated in the narration, but the slide is not referenced explicitly.	Learning Outcomes for the screencast listed within individual rectangle shapes	
Graphic with Text	Semiotic Articulation- Joanne draws viewer's attention to the graphic on screen: *"it's a cyclical process as you can see on the screen in front of you."*	Smart Art Graphic (Block Cycle) to present the elements within the negative feedback loop.	
External video	Semiotic Articulation- while Joanne does not narrate the video, she draws attention to salient points within the video in relation to the	Video focuses on story of a woman and her family to show the emotional effect of hearing loss	

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	concept presented in the screencast.	on an individual.	
Graphic with Text	Unprobed Representation-depictional. A visual representation of the narrative provided by Joanne.	Three linked circle shapes used to present reactions to hearing loss. Arrow assists with direction of narration.	
Graphic with Text	Unprobed Representation-depictional. Again, a visual representation of the narrative provided by Joanne.	Again, linked circles frame key points of the job with arrow to assist flow of information.	

The graphic-pictorial elements for the most part include graphic symbols available within PowerPoint or Camtasia and the external video. As seen in the table above, Joanne moves from unprobed representation to semiotic articulation in the use of the graphic-pictorial elements on the screen. The video played for 2:76 minutes and formed an integral part of the screencast. The video footage is used to present the personal experience of an individual affected by the outcome of the concept.
Joanne's rationale for including the video reveals her perception of the power of authentic, real-world representations of the concept. *"It was very personal, and it was very real. It was very human, with her playing with the children."*
"By using the video, as opposed to me just saying it, it shows that it's actually real. It's human when you see her playing with the children, crying afterwards as to the effect the hearing loss is having."

Linguistic Mode

The agentic nature of the lecturer in reworking disciplinary norms (Bamber, 2012) is evident in Joanne's design of this screencast, where she adopts a different approach to teaching within the discipline. The target audience for this screencast is students completing an NFQ Level 6 certificate, through both synchronous and asynchronous lectures. The concept is presented through the semiotic lens of a lecturer with considerable experience in the discipline. Joanne reports that in year one the subject is *"very scientific. It's the way it is. […] In relation to introducing the hearing loss and the concepts and the physical effects […] that's the bread and butter of what they need to know […] for their practical and clinical exams".*

However, there is a clear move towards *"a different slant on things"* in Year 2, where Joanne feels that the study of the psychological effects is *"making them think in a different way".* The absence of scientific terms is evident and new terminology only extends to the concept of the negative feedback loop. Terms related to the discipline are included but not explained, such as *"interventions […] hearing aids […] assisted listening devices"* [Timestamp: 5:22-5:34] and students are expected to know these. It was clear that Joanne had given considerable thought to the conceptual knowledge required by students on this programme. There is evidence of ways of being within the disciplinary community, e.g., *"we will train these people to think in a certain way, as I said a sort of a scientific way. Because for the practicals, or for obvious reasons, they have to do things the way we've told them."* However, Joanne is eager to provide an alternative conceptual approach, as embodied in the screencast:

"It's such an important thing; they've got to work with real human beings and realise people are different. And the way they react to hearing loss is different."

Joanne undoubtedly has a specific cohort of students in mind as she presents the concept, and there is clear evidence of a discursive relationship with the viewer/listener. There are several instances of the pronoun 'you' [12] in the video, where she is talking directly to the students, while the numerous mentions of the pronoun 'we' [7] suggests a partnership approach to the teaching, including the students as part of the academic community to which she belongs.

Socio-emotional competence is also demonstrated at intervals throughout the screencast. Initially, Joanne welcomes the students and situates the learning within the context of the wider module. During the screencast, she refers to the future careers and future lived experience of her students. The future professional role features as a learning objective at the beginning of the screencast and is the focus of the screencast at a later point [Timestamp: 5:15-5:49]. Joanne tells the students: *"You can help, which*

is the great thing" [Timestamp: 5:15-5:16] outlining the role of the student once qualified. *"You can help stop this cycle of negativity, this cycle of withdrawal and emotional distress" [Timestamp: 5:43-5:50]*, which is a powerful personalised strategy.

Aural Mode

This screencast was categorised in an earlier section as having a high vocal melody, i.e., there is a noticeably wider pitch range as the lecturer speaks and it appears more melodic as a result. Joanne was very aware of the affective nature of the voice in this way and uses pitch patterns, specifically intonation, to emphasise certain key points to highlight the informational value. During the interview, she explains her process: *"Okay, […] at the beginning […] that was talking quite monotone. And then I noticed when I moved on to the next concept, I said also, and I raised my voice a bit. […] I actually raised my voice to sort of show you know now let's go onto the next point. So, I said* ***also*** *[lecturer emphasis] So I don't know if you noticed that? My voice went up. […] And then you notice right at the end that it went, it was very non-monotone […] emphasizes that point […] they're not going to forget that because […] there's this big, raised voice from me, you know?"*

In addition, this screencast features notably frequent use of discourse markers 'so' and 'okay' (11 occurrences of each). Below is a sample of the uses of the discourse marker 'so' by Joanne, to organise the presentation of the concept.

Table 6:5: Discourse Marker 'So'

Opening frame marker (to start a topic)	[Timestamp: 0:27] *"So, often when a person has a hearing loss"* [Timestamp: 1:22] *"So now we're going to watch a video"*
Closing frame markers (to conclude a topic)	[Timestamp: 4:15] *"So as you've seen in that video"* [Timestamp: 1:15] *"So it's a cyclical process"*
Information indicator (to indicate either new or old information associated with the topic	[Timestamp: 5:24] *"So it could be hearing aids, it might be assistive listening devices"*

Structural marker / Referential marker indicating causality To mark structural hierarchy / causality in explanation of concept, i.e., this happened, so this follows…	[Timestamp: 5:11] *"So it depends on the individual"* [Timestamp: 0:48] *"So they might withdraw from social situations"*

The use of 'okay' to check understanding is also quite prevalent in the screencast. This discourse marker is also used to transition from one topic focus to another or to invite agreement/provide reassurance.

Table 6:6: Discourse Marker 'Okay'

Checking understanding and/or progress	[Timestamp: 5:11] *"It might get more serious that they get depressed, okay?"* [Timestamp: 6:08] *"It can start at any point, okay?"*
Transition to a new phase in explaining the concept (Lee, 2017).	[Timestamp: 0:40] "…*as a result of withdrawal, okay?* [Timestamp: 4:17] *"… as you've seen in that video, okay?"*
Interaction Feature (Othman, 2010)	[Timestamp: 5:53] *"You can break that negative feedback loop, okay?"*

Analysis of these discourse markers helps to identify where Joanne places importance in terms of the conceptual knowledge she is presenting. It reveals a discrete semiotic structure and provides an insight into her presentation of the conceptual knowledge in a particular way. The use of discourse markers in this way is unique to Joanne and can change the inherent structure of the presentation or the flow of the narrative.

Spatial-Design Mode

Joanne enthusiastically documents her own digital literacy journey with new digital technologies. A discerning online teacher, she compared the technologies she was

using and where each one was most appropriate *"for live webinars, Adobe Connect ™ is fantastic" but "for delivering materials asynchronously, Camtasia ™ is fantastic."*
Joanne also shows evidence of digital fluency, using digital technologies to enhance the meaning of the intended message, noting:
"[…]I mean, if somebody is just talking at you, and he's going from slide to slide and there isn't much movement, it's boring, whereas some of the key points in that [screencast], if you use the bubbles or the stars or the arrows [Camtasia features] and things like, if you're highlighting it, so it's going in their visual memory as well as the verbal memory […] students learn differently, Some people like verbal, some people like visual."
Joanne had clearly considered the meaning-making potential of technology, *"hoping this will stay in their memory".*

Spatial and Temporal Sequencing

The combination of PowerPoint features and Camtasia tools to create the screencast further showcases Joanne's digital fluency. The use of the Zoom and Pan functionality of Camtasia when explaining the PowerPoint SmartArt Graphic [Timestamp: 0:26-1:10] foregrounds individual elements of the concept initially, then considers them as a semiotic whole. This temporal sequencing removes the extraneous material during narration, revealing an inherent knowledge of instructional design principles.
While spatial sequencing is evident in the presentation of text within circular shapes of equal size, the use of a green arrow as a temporal sequencing tool, which moves from left to right across the screen as the lecturer narrates each point, focuses the viewer on the element in question.

Figure 6:7: Use of Camtasia feature (green arrow) to facilitate temporal sequencing

The Inquiry Graphics analysis framework provided Joanne with an opportunity to reflect on the semiotic choices made within one key moment of the screencast. It was clear from the IG analysis that she had reflected critically on the meaning-making potential of modes within the screencast and demonstrated a semiotic awareness in terms of the intended message. Further analysis of this screencast provided an opportunity to uncover a range of additional semiotic choices on the part of the lecturer in the presentation of the concept.

6.3. Screencast #3: Microbial Bioplastics (Aoife)

At the time of data collection, this lecturer was relatively new to teaching with four years' teaching experience within a scientific discipline. Aoife uses a combination of PowerPoint slides, a simulation, and an external video to explain the concept of microbial bioplastics to her students. As before, the thumbnails below represent a visual of the information presented at each moment in time within the screencast. The original narration for both the simulation and the video is replaced by a narration from Aoife. Some of the thumbnails are repeated where additional elements have been included, such as an image or callout text. Thumbnails from the external video are included and represent each frame within the video. The yellow brackets indicate the beginning and end of the external resources.

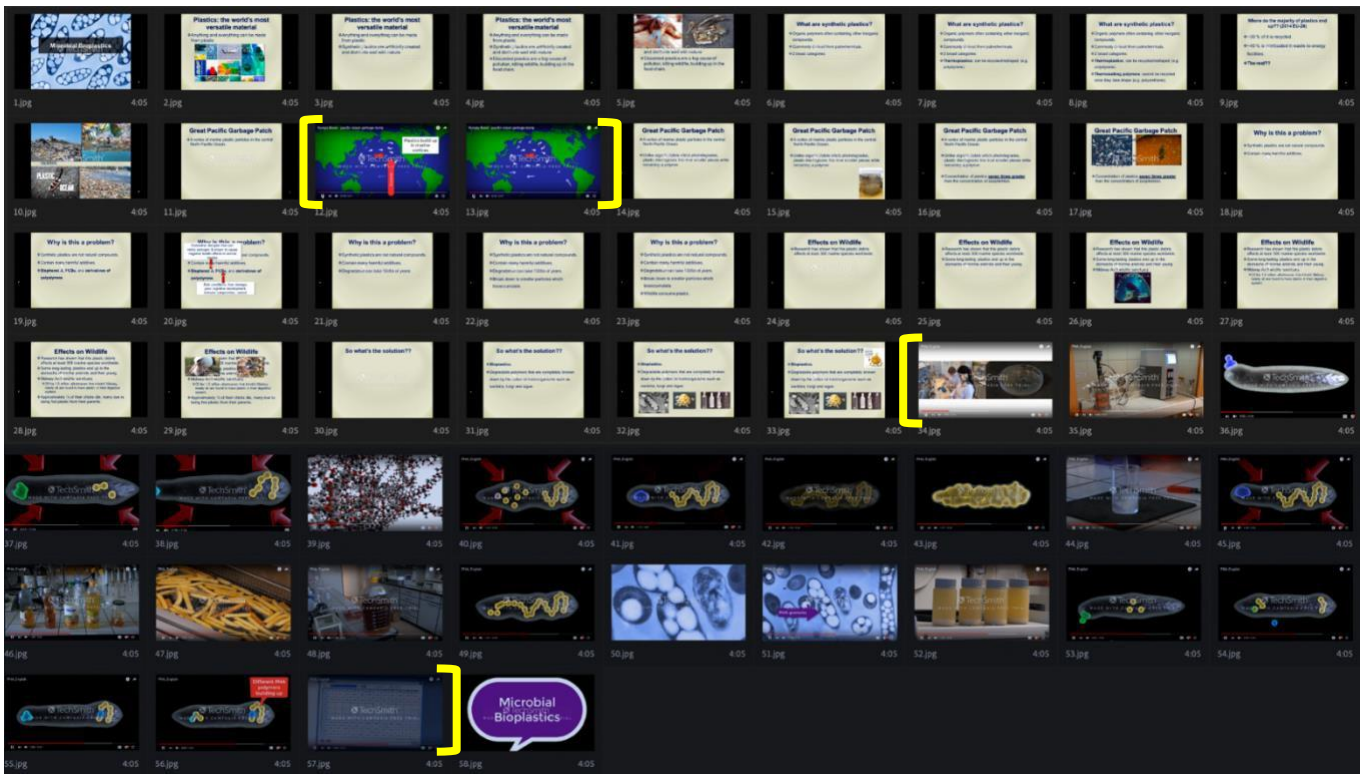


Figure 6:8: Visual composition of screencast #3

6.3.1. Inquiry Graphics Analysis

In this section, we continue the use of an Inquiry Graphics approach to analyse the screencast to examine the semiotic choices revealed within the design and creation of the screencast. Lecturer agency is evident in the design and composition of the screencast, in which PowerPoint slides and external videos are combined and narrated to communicate the conceptual knowledge to students e.g., *"sometimes you might have to put a couple of things together to get the overall picture".*

In contrast to the previous screencasts, the slide chosen for the Inquiry Graphics analysis activity was not one of those included in the key moments listed by Aoife. This was one of the few collages included amongst the 16 screencasts and I had categorised it as an unprobed representation of the concept, i.e., a depiction not directly referenced in the lecturer's narration of the slide. I was interested to hear Aoife's interpretation of such a collection of images as they related to the concept of microbial bioplastics, which explains my rationale for including it here. All four modes are present at this point in the screencast (Graphic-Pictorial, Linguistic, Aural, and Spatial-Design). The table below provides the detail of the Inquiry Graphic Activity.

Figure 6:9: Key Moment [Timestamp: ~0:07-0:15]

Table 6:7: A synopsis of the IG analysis activity

1.Representamen- List what you see / hear (key words) on the screen	**2.Interpretant**- Describe what you see/hear		**Speech-** Transcript from screencast	**3.Research Object**- what does this mean in this research context? How does this visual representation connect to content knowledge? How does this help learners learn about microbial bioplastics?
	Denotation - (basic description)	**Connotation-** what does this mean?		
Colours (shades) *Some objects* *Boxes* *Bottles* *Image* *Text* *Travel*	*"I would say, objects that are made, can be made out of plastic."*	*"Well, to illustrate the diversity of plastic as a material"* *"Parts of cars, and airplanes- everything really"*	*"Plastic is a very versatile material. Anything and everything today can be made from plastic"*	*"Well, I suppose the fact that, given the versatility of plastic, it's a material we're not going to completely turn away from so they need to think about alternatives that are less harmful… would be the overarching message."* *"I suppose until you actually sit back and start to consider all of the different things […] you kind of don't think airplane equals plastic, but the seats, you know all the little bits and bobs, the tray tables, everything."* *"Even all of the catering stuff like the little cups, I'm sure they're not all biodegradable."*

The following section explores the Inquiry Graphics analysis in more detail, using interview and screencast data, as before, to illustrate the points made.

The image presented here remained on screen for approximately seven seconds, during which Aoife repeated the text provided on screen. Following an explanation of what to list for the **Representamen**, she sought clarification on what I was looking for: *"so it would be things like colour, image?"* Interestingly, the colours on screen were the first things noted on the list, followed by objects and while Aoife used nouns as prompted and proposed "*just image, text and then travel"*, the analysis did not go beyond this level of detail.

Aoife used the discourse marker *well* quite frequently at the beginning of a number of explanations to qualify her response *"well, I wrote down", "well, to illustrate the diversity", "well, just parts…", "well, I suppose the fact that…", "well, I suppose maybe they are…"* and seemed uncomfortable at having to deconstruct the image, notable by comments such as *"I hope"* when asked to break down the image.

Aoife was subsequently asked to focus solely on the voice, i.e., what was said and how it was said. Her unease at analysing her own voice was evident, as she raised her eyebrows and grimaced. The initial response when the clip was replayed was *"I don't know how the students can listen to me!"* However, following this, a more reflective commentary was offered, *"Well, I suppose, I try to, you know, be kind of clear and slow in my speech."* When asked if she felt the voice added to the value of the screencast, Aoife was confident that voice was important, however uncomfortable it was for the lecturer to listen to. She notes:

"I can see how in videos the voice does add. I find it difficult, see when it's your own voice. Because it sounds so strange" […] "I suppose when it's not played back to me, I can talk away, but it's when you're hearing it, because in your head you think I don't really sound like that [laughter]."

For teaching in general, Aoife was clear on the importance and value of *"talking through things, narrating, or I suppose even when working with students in a lab and you're describing things as you're carrying out experiments."* While the initial analysis provided a knee-jerk response to interrogating one's own voice, on deeper reflection, it emerged that Aoife considered the voice to be an important semiotic tool.

6.3.2. Interconnectedness of Modes

The use of voice reinforces the visual conceptualisation of the message in many cases throughout the screencast. In one instance Aoife uses narration to reinforce the negative impact of plastics on wildlife, emphasising the word *"die"* while two images of albatross chicks appear on screen. Photographs are often presented in groups of two

or three on a slide with corresponding text, revealing Aoife's multimodal anchorage to help students better understand the concept.
In the following section, the screencast as a whole is examined, using the MMI framework as before.

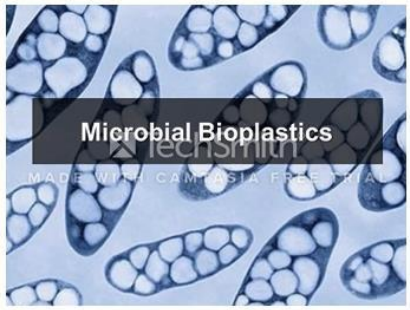
6.3.3. Multimodal Inquiry

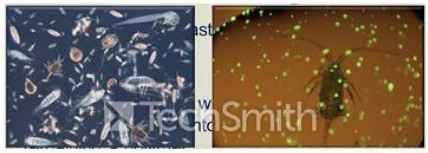
As before I move now to a zoom-out approach to explore the affordances of each mode present in the screencast.

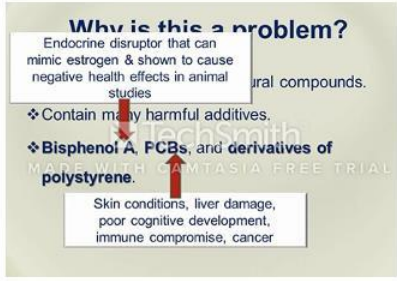
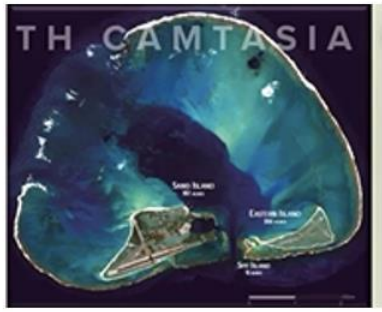
Graphic-Pictorial Mode

The graphic-pictorial elements are listed below as they appear chronologically within the screencast. The main type of pictorial element is the photograph, with a total of 17 images included within the 4:28 minute-long screencast. These are often presented in groups of two or three on a slide with corresponding text, shown simultaneously. Two of the graphics have a purely attentional purpose, while all others have a role in depicting the concept referred to in the lecturer's narration.
Semiotic articulation, where the lecturer directly references the images, is not evident within the screencast. Similarly, semiotic invitation, i.e., where students are invited to interrogate the images presented, is absent. Apart from the title slide, where a pictorial representation of the title is used as a background image, all other graphic- pictorial elements are included near or overlaid directly on text. They constitute conventional depictions (Lacković, 2018) of the issue, which scientists are trying to find solutions for, such as the one presented in this screencast. According to Aoife, it's important to provide context but the students like to see *"that there are some potential solutions".*
The pictorial elements chosen are in some cases quite graphic and Aoife's intentionality in communicating a specific message is clear as she acknowledges the effect this topic has on students:
"I often get a really big reaction from them (students)*, I've had girls nearly crying in class because of course, just the associated effects on wildlife and all the dead birds, and the mammals, and they find it really upsetting."*
The importance of the graphic-pictorial mode is further demonstrated through the significant number of elements included in the short screencast, as detailed below.

Table 6:8: Graphic-pictorial elements in screencast #3

Categorisation / Modal Element	Semiotic Referencing in Lecturer's Narration	Description/ Comments	Graphic
Photograph	Unprobed representation-depictional	Photograph of *"microbial cells building up a biodegradable polymer within their cell walls"* used as background image for title slide	 (Full slide)
Collage	Unprobed representation-depictional	Collage of 14 images of uses of plastic. Also includes a logo from BPF-British Plastics Federation	
Photograph x2	Unprobed representation-depictional	Photographs of a turtle and a dead bird, both with plastic in their digestive systems.	 (Pictorial Elements overlaid on text- top of slide)
Photograph x4	Unprobed representation-depictional	4 photographs of the ocean showing	

		significant amounts of waste, including plastic.	 (Full slide- pictorial elements overlaid on text)
External video	Unprobed representation-depictional	Simulation of currents in marine vortex of Pacific Ocean	 (Full Slide)
Photograph	Unprobed representation-depictional	Container with water which has particles of plastic.	 (Pictorial element positioned on bottom right of text slide)
Photograph x2	Unprobed representation-depictional	Two photographs of organisms under microscope. Assumption that students	

		would know what zooplankton is and where it is visible in images.	(Pictorial Elements overlaid on text- top of slide)
Graphic with Text x 2	Unprobed representation-depictional	2 x Callouts with red arrow linking to key terms on the slide.	 (Full Slide)
Photograph	Unprobed representation-depictional	Photograph of the Midway Atoll Wildlife Sanctuary located in the Pacific Ocean	 (Full Slide)
Photograph x2	Unprobed representation-depictional	Both images appear simultaneously . First image shows parent albatross feeding chick. Second image shows dead albatross chick with plastic in its beak.	  (Pictorial Elements overlaid on text- top of slide)

Photograph x3	Unprobed representation-depictional	3 images appear simultaneously, depicting various stages of degradable polymers. In the first image, the cell under microscope is visible. In the second image, the physical polymer is shown, while the final image shows the stages of biodegradation.	 (Pictorial Elements positioned at bottom centre of slide under text)
Clipart	Unprobed representation-attentional	Clipart of bacteria with sign: 'we're not all bad'.	 (Pictorial Element positioned at top right of slide beside title)
External video	Unprobed representation-depictional	Video which shows a simulation of microbes grown in the lab, in addition to footage of a	 (Screenshot of first frame of video)

		laboratory environment.	
Graphic with Text overlay on External Video	Unprobed representation-depictional	Addition of Camtasia™ callout feature to draw attention to PHA granules within a cell.	 (Graphic Element positioned at top right of video for ~1 second)
Graphic with Text overlay on External Video	Unprobed representation-depictional	Addition of Camtasia™ callout feature to draw attention to the build-up of different PHA polymers	 (Graphic Element positioned at centre left of video for ~1 second)
Graphic with Text	Unprobed representation-attentional	Speech bubble with title as end slide	 (Graphic Element used as end slide)

Linguistic Mode

Although the issue described initially within the screencast is quite topical for the general public (i.e., plastic pollution), it clearly has a scientific focus, and a number of key scientific terms are used without explanation. It is assumed that students have the disciplinary knowledge required to understand these terms and progress through the screencast. Some examples of such scientific concepts include “organic polymers”, “inorganic compounds”, “petrochemicals”, “thermoplastics”, “thermosetting polymers”, “photodegrade”, “zooplankton”, “natural compounds”, “bisphenol A”, “PCBs”, “polystyrene”, “bioaccumulate”, “short chain length and medium chain length”. The main concept, which is the subject of the screencast (microbial bioplastics or polyhydroxyalkanoates - PHAs) is first mentioned at 3:31 minutes with a detailed explanation.

The target audience for this screencast is students completing a degree in biotechnology, investigating the *"whole problem with micro plastics, plastic pollution in the environment and then solutions"* and Aoife clearly had this cohort of students in mind when designing the screencast, which *"displays nicely to students how it works in practice, as opposed to just you know, the theoretical, text-based stuff."*
According to Aoife, at this point students are already familiar with the techniques used to study microbes, so she builds on this knowledge with the current concept, which *"just kind of falls naturally"* into the curriculum at this stage.
Aoife situates the concept within the context of the scientific discipline during the qualitative interview. Her social semiotic context is evident in references to *"demonstrating procedures in the lab"* and *"working with students in a lab."* While some students find this concept distressing, Aoife argues that asking the question "What is the solution to this environmental crisis?" within the screencast actively focuses the students on their role within the scientific community and how they can contribute to improving the situation.

Aural Mode

This screencast is considered to have a high vocal melody, with pitch changes noticeable throughout the screencast. The table below provides some examples of the different uses for intonation (in bold); however, the tonal variation of Aoife's voice is evident throughout the screencast.

Table 6:9: Examples of uses of intonation (text in bold font denotes emphasis)

Category	Examples within the screencast
Change in focus of topic	[Timestamp: 0:16-0:20] *"**However,** synthetic plastics are artificially created"*
Use of superlative	[Timestamp: 0:23-0:25] *"**huge** cause of pollution"* [Timestamp: 2:17-2:19] *"cause **huge** problems for wildlife"* [Timestamp: 2:42-2:44] *"**huge** albatross population"*
Introduction of key terms	[Timestamp: 0:33-0:36] *"**Organic polymers, inorganic compounds"*** [Timestamp: 0:44-0:49] *"**thermoplastics** and **thermosetting plastics"***

	[Timestamp: 3:02-3:04] *"**bioplastics**…"*
Underlining negative impact	[Timestamp: 0:26-0:29] *"killing **wildlife**…"* [Timestamp: 1:29-1:34] *"don't **photodegrade**, just **break down**"* [Timestamp: 2:45-2:48] *"Nearly **all** of them are found to have plastic in their **digestive system**"* [Timestamp: 2:51-2:53] *"one third of chicks **die**"*

Discourse markers

The use of discourse markers in the narration of this screencast adds to the cadence of Aoife's voice in connecting elements of the concept. She uses the discourse markers *so* and *well* when introducing a new element within the concept. Below are some examples:

Table 6:10: Use of discourse markers 'So' and 'Well'

Timestamp	Quote
0:30-0:32	*"**So**, what are synthetic plastics?"*
1:47-1:49	*"**So**, why is this a problem?"*
2:57-2:59	*"**So**, what is the solution to this environmental crisis?"*
0:54-0:55	*"**Well**, according to EU research…"*
1:49-1:51	*"**Well**, synthetic plastics are not natural compounds…"*

Each question or statement leads on from the previous section and the discourse markers are used as an opening frame marker.

As mentioned earlier, Aoife was clearly uncomfortable when listening back to the screencast exclaiming *"Oh my voice!"* at one point. Recognising the difference between live teaching and a recording, which is *"recorded for all time, for posterity",* Aoife notes that *"with certain terminologies […] you would be very aware of pronouncing things properly*" but also *"on some of the slides where […] it's with the defects on wildlife, maybe there's […] more of a tone of, this is a terrible thing."* Confident that the voice can convey a sense of solemnity, Aoife also acknowledges that her own emotions may come through in her teaching, *"when there are things of*

interest." She admits that she is more invested for this: *"you will bring more of yourself into it, or you'll convey something."*

Finally, when asked about the main carrier of meaning, Aoife decides it has to be the voice *"it wouldn't have the same impact without the voice."* Reflecting on the inclusion of three modes (Aural, Linguistic and Graphic-Pictorial) Aoife organises them in a hierarchy:
"I suppose the images, you'd need the text with the images to explain what they mean. I would actually think the voice would probably have it over the text." Referring to the specific cohort of students who are the intended audience for the screencast, Aoife feels that there is resistance to reading, but with the introduction of the voice and images *"you know they're looking at images and they're listening to what you're saying."*

Spatial-Design Mode

In contrast to the previous screencast, Aoife admits she *"did **not** [lecturer emphasis] get on well with [Camtasia] really at all"* and found the process of editing the online instructional video challenging, *"I kept getting that wrong and having to go back and go back."* However, although she used the phrase *"technologically challenged"* to describe herself, I would argue that she demonstrated considerable digital literacy when it came to screencasts in general, using Camtasia features such as callouts, transitions, and embedded videos within the screencast to help explain the concept. While the screencasting tool Camtasia presented challenges, Screencastomatic (another screencasting tool) proved much more popular. She notes: *"Oh I love that." "We'd […] video stuff on the phone and then put it together, individual files using Screencastomatic™ and I found that really easy to do."*

Although she uses a lot of YouTube videos for her teaching, Aoife also uses other methodology videos from an institutional repository which is *"like a virtual journal."* However, she moderates the content, since *"some of the videos are very short on detail, particularly around methods carried out in the lab", "I have seen a lot of student-made videos, […] they're kind of nice, but they're quite lacking in detail".* Here we see evidence of Aoife's disciplinary expertise, as she considers the detail required for students to fully understand the concept and she often combines resources to "*get the overall picture"*. This shows a considerable degree of digital fluency and an awareness of the potential of multimodal resources for teaching within the discipline.

Spatial and temporal sequencing

Aoife demonstrates good use of PowerPoint for spatial and temporal sequencing within the screencast. Some of the slides contain simultaneous or sequential image overlays on existing text and together with the narration of the slides, provide a multimodal explanation of the concept in question.

PowerPoint animation is used to sequence elements, in particular where key terms are introduced (e.g., at Timestamp: 0:43-0:48 for Thermoplastics, Thermosetting plastics) or to present graphic-pictorial elements which relate to a specific point (e.g., at Timestamp 2:39, which presents an image of the Midway Atoll Wildlife Sanctuary), removing them as she moves on to the next point. However, research would suggest that concurrent presentation of modes (Khacharem et al., 2020) provides better results in terms of learning. An implicit understanding of UDL principles is evident in the choice of pastel colours as a background colour and the use of Sans Serif font throughout the presentation.

Aoife crafted a rich multimodal screencast to present the topic of microbial bioplastics. The combination of graphic-pictorial, linguistic, aural, and spatial-design elements contribute to a comprehensive multimodal ensemble, where she combines the affordances of several modes to communicate her expert understanding of the concept to her students.

6.4. Conclusion

In the previous chapter I included an overview of the range of screencasts selected for analysis within the thesis and presented the multimodal inquiry framework as it applied to the screencasts. In this chapter, I drill down into three screencasts to examine in detail the use of an Inquiry Graphics framework to reveal the semiotic choices of the lecturer, and follow this with the application of the MMI framework to analyse the "semiotic organisation of the resource for meaning making" (Adams-Tukiendorf et al., 2022, p.13) and explore how the ideas and the screencast elements are brought together. Both chapters focus on the analysis of the multimodal screencast to answer the first research question, which asks how a multimodal inquiry framework, which builds on an Inquiry Graphics approach, can be used to teach key concepts within an academic discipline. In the next chapter, I discuss this alongside the two remaining research questions and draw conclusions based on the findings above.

Chapter 7: Discussion

This thesis set out to examine lecturers' meaning-making practices, as they relate to the creation of multimodal screencasts to teach disciplinary concepts in a higher education context. A multimodal inquiry (MMI) framework, which extends an Inquiry Graphics framework, was developed to analyse the screencasts to discover the semiotic choices that were made, how these choices revealed meaning-making practices, and whether these choices were influenced by the sociocultural practices and situated context of the lecturers. The following section initially presents some general conclusions on the use of MMI framework as it applies to the digital screencast lectures and is followed by a more detailed discussion of the research questions.

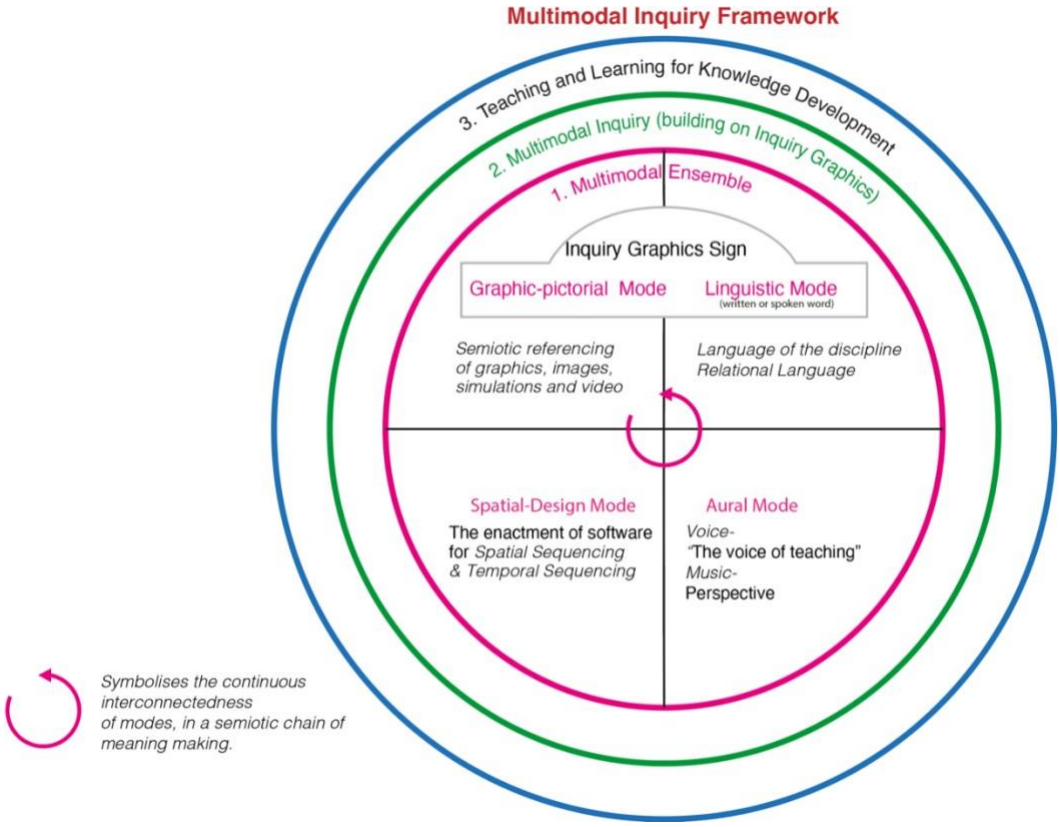


Figure 7:1: The multimodal inquiry framework

Layer 1: Multimodal ensemble

What emerged from the study is a clear sense that the design and composition of the multimodal screencast revealed a lot about lecturers' semiotic choices, supporting Jewitt's (2013) argument that Image, Text, Speech and Sound are semiotic resources for meaning making. While all four modes were used in all screencasts, the semiotic

arrangement of modes (Kress & van Leeuwen, 2006) was quite different depending on the lecturers' consideration of specific modes as major or minor carriers of meaning and the semiotic weighting given to the different modalities within each discipline.

Layer 2: Multimodal Inquiry

Additionally, the use of the MMI framework allows for the guided inquiry (Lacković, 2020) of digital artefacts such as the screencast. Through the inquiry of individual modes and their elements, it is possible to explore lecturers' intentions and their semiotic preferences, offering an insight into their "ways of knowing and communicating" (Literat et.al, 2018, p.568). Critical inquiry was evident during the Inquiry Graphics analysis activity completed with lecturers and helped to identify "the intent and the intentionality" (Lacković, 2020, p.109) of lecturers' modal choices used within their digital screencast.

Layer 3: Teaching approaches to knowledge development

From the perspective of lecturer professional development, the MMI framework provided an opportunity to explore lecturers' pedagogical choices as they are embodied in the digital resources they created. It helped reveal lecturers' technological, pedagogical, and content knowledge (Mishra & Koehler, 2006), such as for Patrick's screencast on *Food Allergy and Food Intolerance,* or Joanne's screencast on the *Psychological Effects of Hearing Loss.* Both lecturers were selective in their choice of digital technologies and revealed an acute awareness of their audience and how they should structure their teaching of the concept to suit their students. However, the enactment of a lecturer's learning design is not only dependent on their digital literacy or digital fluency, as described by Miller and Bartlett (2012), it is also the embodiment of their social, cultural, professional, and historical experiences and their unique and differential (Jappy, 2013) interpretation of signs in this context. As such, professional development programmes should consider the inclusion of multimodal semiotic awareness, to ensure lecturer-designers are cognisant of the semiotic impact/affordances of different modes and the multimodal composition of digital resources.

7.1. Answering the research questions

The key questions guiding this qualitative research are listed below. The overarching question asks:

What multimodal affordances are selected by university educators in digital multimodal screencasts to teach key concepts within their specific disciplines and how are these applied?

This is further divided into the following questions:

- How can the use of a multimodal inquiry (MMI) framework, developed by the thesis researcher, that builds on an Inquiry Graphics approach, support the teaching of key disciplinary concepts?
    - How are key disciplinary concepts articulated through the multimodal ensemble of the screencast?
    - How are conceptual ideas and screencast elements brought together?
- How is the multimodality of the screencast related to the sociocultural practices of the lecturer and their situated context?
- What are the implications of the findings for an understanding of online and screencast-based teaching as a relationship between knowledge and its multimodal elements and affordances enacted through digital technologies – how do the two relate and what does that mean for teaching practice?

The following section responds to each of the questions above.

7.2. How can the use of a multimodal inquiry (MMI) framework, that builds on an Inquiry Graphics approach, support the teaching of key disciplinary concepts?

I propose that the multimodal inquiry framework can support the teaching of key disciplinary concepts in two ways. Firstly, if used as a professional development tool with lecturers, it can provide a valuable insight into their own meaning-making practices, enabling them to make informed choices about:

a) The affordances of the modes they choose to include in the screencast, which is interpreted as a multimodal sign of learning. This research has highlighted several affordances of the four modes often included in the screencast, i.e., graphic- pictorial, linguistic, aural and spatial-design. Analysis of these modes can prompt critical reflection on the choice of modes chosen for the representation of knowledge (Jewitt, 2003a).

b) The knowledge they choose to include about the concept, based on their conception of the world, (Kress, 2010), to maximise student understanding. For example, to help students understand the *Psychological Effects of Hearing Loss*, Joanne chose to include the authentic account of someone who suffers from hearing loss, while Patrick included definitions on the key terms related to *Food Allergy and Food Intolerance*.
c) How they approach the teaching of this concept within the screencast. Yıldırım (2021) reported that students did not value a didactic approach to the screencast in a study of students' views of screencasts for teaching GIS. Relational teaching and a discursive relationship with the viewer were evident in a number of the screencasts within this study and point to an increased focus on relational pedagogy, moving away from the neoliberal, uncaring system of HE as called for by Gravett et al. (2021).

Additionally, lecturers can use the framework with their students as a guided inquiry tool (Lacković, 2020) to unpack information about a concept presented in a variety of modes. Through critical inquiry of the message communicated in the multimodal screencast, lecturers can help students to develop their critical media literacy. This is supported by Tan et al. (2020), who argue for an extension of literacy beyond the linguistic mode, while the concept of critical graphicacy is introduced by Lacković (2020) to interrogate the visual representations of the world.

In the following section, I expand on the above points to explore how the MMI framework helped uncover meaning-making practices of lecturers as embodied in the screencast, a "multimodal whole" (Jewitt, Bezemer, & O'Halloran, 2016, p. 2). This provides an additional layer for reflection on and critical engagement with resources that lecturers create for their students.

The starting point for this research was a desire to find out why lecturers craft their digital resources in a particular way. The Inquiry Graphics (IG) framework (Lacković, 2020) offered a way to unpack information presented in a variety of modes, in a "slow, analytical and semiotic" (p.16) manner to potentially reveal the meaning- making practices of the creators/presenters of this information. Providing "interpretative guidelines" (Lacković, 2018, p. 1) for those wishing to analyse multimodal resources such as video, Lacković argues that Inquiry Graphics can provide a framework for "serious academic inquiry" (Lacković, 2020, p. 366) through a series of analytical steps using Peirce's triadic sign. For this research study, the IG framework was used within the qualitative interviews to unpack the meaning-making practices of the lecturers

within the multimodal screencast. The extended IG activity revealed a number of interesting points.

Firstly, the analysis of their own work at such a granular level was new to many of the lecturers and some openly admitted that they struggled with this semiotic engagement (Stables, 2006), especially the initial phase of the activity. Others were more successful but combined both the *Representamen* (List) and *Denotation* (Describe) phases, again revealing the difficulty in stripping the resource back to its component parts. Almost immediately, they offered a description within the context of their discipline. However, the guided nature of the inquiry provided them with an opportunity to reflect on some of the design decisions they made in terms of the message they were communicating through the modal elements, admitting in some cases that they either couldn't separate out the image from what it meant in their discipline, or simply never really looked at these elements in detail. They were focused on selecting suitable content and an appropriate pedagogical approach, revealing PCK (Shulman, 1986). However, the IG activity provided an additional lens through which to view their digital resources, i.e., the examination of their semiotic design choices and the potential for meaning (Kress, 2018) these offer. The realisation that the intended meaning by the initial maker (ibid) may not be communicated was stark for some lecturers, underlining the importance of and need for critical reflection in digital pedagogy design. Since teachers have considerable agency and are "constantly reworking disciplinary norms" (Bamber, 2012, p. 99), due care should be given to how they choose to design the 'message'.

One lecturer reflected on this phase of the IG activity (*Representamen)*, noting it compared to their attempts to pare their resources back for visual noise, so as not to overwhelm students, but for the most part lecturers were uncomfortable with this phase. This may be explained in part by the fact that the focus of TEL and the other professional development modules completed by these lecturers is primarily on pedagogy rather than semiotic engagement with resources. While reflective practice is an integral part of the professional development module, critical reflective inquiry from a semiotic perspective on the design and selection of resources is not. As

educators create and use more and more digital resources in their teaching, I agree with Literat et.al (2018) who contend that multimodal inquiry should be an integral part of higher education. However, I argue that this should begin with the professional development of lecturers, where guided inquiry can help them with the initially uncomfortable and potentially troublesome process of semiotic engagement. As stated above, the multimodal inquiry framework may serve as a useful tool to structure this guided inquiry and provide lecturers with a tool they can take into their classroom to develop their own students' critical inquiry.

Most lecturers were most comfortable in the *Connotation* phase, i.e., where they were asked to explain the meaning of the modal elements. They were visibly more at ease and articulated readily how these elements fitted into the broader disciplinary concept, demonstrating their content and pedagogical knowledge (Shulman, 1986). The final phase of the IG activity was most relevant to the research question which guides this study and again lecturers articulated promptly how the screencast contributed to the development of students' knowledge within the discipline. Here, a number of lecturers highlighted the affordances of different modes, showing evidence of competency in technological, pedagogical content knowledge (Mishra & Koehler, 2006). If educators approach pedagogy as design (ibid) and consider these designs from a semiotic perspective, the potential for meaning making becomes an important consideration of the design process. Professional development programmes would benefit from including this guided reflective inquiry (Lacković, 2020) phase into the design process of pedagogical resources, using the multimodal inquiry framework to scaffold the inquiry and reveal the meaning-making practices of the lecturer- designers. In addition, a practice-oriented approach facilitates the implementation of strategies that educators encounter within professional development programmes. I make the case that lecturers could include similar guided inquiry activities in their teaching, using the MMI to embed semiotic engagement in their discipline and explore the plurality of meanings behind digital resources they use to teach disciplinary concepts.

Guided inquiry also promotes the development of critical media literacy, which is more important today than ever before, given the proliferation of digital resources and the potential for media manipulation (Kellner & Share, 2005). In an increasingly hyper-visual world (Lacković, 2020b), the modification of images in particular necessitates a deeper analysis of the creator's intentions. Critical graphicacy encourages this examination of images, inviting students to ask questions to enhance their understanding of the concept (Hallewell & Lacković, 2017). Critical multimodal literacy

extends this concept to other modes to critically engage with how each of the modes are used and the semiotic meaning of these. A workshop with students (Appendix 3 Vignette), in which a multimodal inquiry approach built on an IG framework to explore one of the screencasts included in this research study, demonstrated how students can critically engage with teaching resources, such as the multimodal screencasts. Instead of using the digital resource to present a single conceptual view, it can be used to explore the potential plurality of meanings, through the examination of individual modes, but also through the multimodal ensemble (Jewitt et al., 2016).

7.3. How are key disciplinary concepts articulated through the multimodal ensemble of the screencast? How are ideas and screencast elements brought together?

Key concepts: types of knowledge represented

The analysis of disciplinary concepts represented within the screencast revealed both declarative and procedural knowledge, as defined by Biggs & Tang (2011). While the majority of screencasts focused on presenting a theoretical concept within the discipline, a small number demonstrated functional knowledge, i.e., the knowledge required to perform a particular action (such as *Accessing the BNF online*), or a combination of both (e.g., *Referencing using MS Word*). Lecturers' rationale for the use of the screencast within their disciplines to explain difficult concepts (Meyer & Land, 2003) or conceptual building blocks (core concepts) mirrored that reported by Galligan & Hobohm (2013), Miller & Zhao (2017), Powell & Wimmer (2015), and Tunku et al. (2013).

7.3.1. Knowledge as developmental

All of the lecturers operate in an outcomes-based educational system, where knowledge is presented as the product of learning and students are the recipients of knowledge (Arends, 2015; Schunk, 2012; Slavin, 2012). However, the research revealed that lecturers increasingly perceive knowledge as developmental (Scardamalia & Bereiter, 2006), and learning as a process "of coming to be" (Jewitt, 2009, p. 28) through participation within a community. Joanne had considered the role of her students as future audiologists and as Year 2 students, felt it was time for them to take a different slant on their learning process, moving beyond scientific facts to think differently. Aoife focused on students' role as part of a scientific community where they can contribute to finding a solution to the plastics problem. This approach places an emphasis on learner agency (Lave & Wenger, 1991) and recognises the role all members of the academic community play in advancing knowledge.

This experiential approach to knowledge requires lecturers to be more aware of the social, cultural, and historical situatedness of the learner (Archer et. al., 2016), helping students to learn through connecting the intrapersonal with the interpersonal (Shawa, 2020). In this study, many lecturers were mindful of students' sociocultural context and applied the concept to scenarios in their world. Examples include Sophie, who referred to students' studying for exams, in *Social and Emotional Benefits of Physical Activity*, or James, who provided examples of transformers in a context that students would be familiar with in *Introduction to Transformers.*

Additionally, Patrick makes several references to the wider sociocultural context in his screencast on *Food Allergy and Food Intolerance* (FSAI, HACCP, EHO, etc.), which his students would be familiar with. However, not all lecturers did this.

Discussing her screencast on *Full Wave Rectification*, Brenda admits that one of the images she used was generated in the United States (US), which is not local to her students' context. The IG analysis activity provided her with an opportunity to scrutinize her semiotic choices, which she acknowledges she would not necessarily have done before.

7.3.2. Disciplinary Concepts and the Screencast

From analysis of the interview data, the concepts presented within the screencasts were significant within the discipline, providing a justification for the design of the instructional screencast to teach threshold (Meyer & Land, 2005) and core concepts. Participants were cognisant of the transformative nature of these "conceptual gateways" (ibid, p. 373), noting that once students understood the concept, it opened up a "*whole world […] in front of them"* (**Frank, Engineering Lecturer**). The troublesome nature of the concepts was also epitomised in the metaphor of passing through the eye of a needle (**Frank, Engineering Lecturer**), i.e., difficult but necessary for students to move beyond the liminal space (Land et al., 2014).

However, this is not merely a cognitive process. Feelings of upset, frustration and even fear amongst students are reported by lecturers as students try to navigate this space and struggle with an understanding of the concepts to the point where "*getting it wrong frustrates the students so much that they lose belief that they know how to do anything"* **(Joseph, Science Lecturer).**

The affective and relational nature of learning needs attention according to Ellsworth (1997), supporting students as they struggle with troublesome concepts, and reminding them that they are not alone. Otherwise, strategies such as mimicry are inevitable, as noted by **Joseph** (**Science Lecturer**) *"just because they saw words in the question*

that they thought fit into a formula that they learned off". Though it is not fair to say no learning has occurred, (Meyer & Land, 2005, p.377) argue that mimicry is an attempt "at understanding and troubled misunderstanding", students do not engage deeply enough with the concept to arrive at a new understanding.

The excursive and recursive nature of learning (Cousin, 2006) is evident in the responses from lecturers who scaffold the learning for their students, to help them achieve conceptual understanding. They consider the interconnected nature of elements of the concept and build a jigsaw puzzle (**Joseph, Science Lecturer**) or simplify concepts and add on all the little bits (**Brenda, Engineering Lecturer**), so that students can build their conceptual understanding incrementally. Additionally, lecturers used real-world examples of the concept in situ, such as in the screencast on *Accessing the BNF online*, where Keith suggests this knowledge will be important at 12 o'clock at night in Mayo (county in Ireland).

However, to present the concept to as wide a range of students as possible, lecturers were clear that they needed to use multiple modes. The screencast provided a platform for the visualisation of the concept *"to put pictures to the words"* (**Joseph, Science Lecturer**), but also allowed students to listen to the lecturer as they explained the concept. Lacković (2020) proposes that *Threshold Graphics* can provide a theoretical approach to the representation of threshold concepts in iconic image form. It would seem from the screencasts and interviews that lecturers agree that the representation of threshold and core concepts in multimodal formats can lead to a better conceptual understanding, suggesting that *Threshold Graphics* may have an important role to play in the teaching of threshold concepts in our multimodal, pluralistic educational contexts.

7.4. The Multimodal Ensemble - how ideas and screencast elements are brought together

In the multimodal screencast knowledge is shaped through the modal affordances (Jewitt, 2003b) and arrangement of modes (Kress, 2015). The composition of the screencast, facilitated through technology, provides lecturers with an opportunity to create a semiotic unit, where each mode partially represents the meaning of the whole (Kress, 2015). Using a combination of modes means the students have a better chance of understanding, and lecturers were also conscious of accommodating different learning preferences *"I also think that if I include the pictures, I'm not upsetting the students who get the words, but I'm helping the ones who don't, I think."* (**Joseph, Science Lecturer**). Multiple means of representation form part the core principles of Universal Design, which advocates a more inclusive approach to learning design (Matthews et al., 2022). Lecturers commented on the importance of an inclusive learning design for students, demonstrating an awareness of how their choice of learning design could impact the students' learning, e.g., Joanne felt that the voice (aural mode) might be more important if someone was visually impaired, but if not, then the arrangement of elements on screen (spatial- design mode) would be the main carrier of meaning within the screencast.

Lecturers were confident in their use of modes as major and minor carriers of meaning. Often dependent on accepted customs within the discipline (Jewitt et al., 2016), the choice of mode to be the main carrier of meaning may reflect the epistemological view of the collective (Wacquant, 2005). Interestingly, the visual mode (graphic-pictorial) is listed as the main carrier of meaning for two of the screencasts included in the detailed analysis, while the voice is chosen for the third screencast. This modal preference is reflected in the design of the screencasts, where the main carrier of meaning is more prevalent. However, though two of the screencasts from this subset are within the Science disciplines, they do not share the same modal preference as a main carrier of meaning. This may be explained by the fact that each belongs to a different community within the Sciences (Health Sciences and Life Sciences) with potentially different epistemological views about how knowledge should be communicated. It is notable that some early career lecturers (e.g., **Brenda, Engineering Lecturer**) place significant emphasis on the Linguistic mode, while the other lecturers move away from this logocentric approach to include other modalities. This may indicate that as lecturers become more experienced at teaching, they become more comfortable moving away from the traditional teaching modes to explore new ways of representing knowledge within their discipline. This points to the agentic nature of the lecturer, as

part of an academic community that decides how knowledge is represented within the community (Lacković, 2020) and who is constantly reworking the “disciplinary norms” (Bamber, 2012, p.99).

The following section uses the multimodal inquiry framework to unpack the meaning-making potential of each of the modalities. I start with the graphic-pictorial mode, since it was evident that this was the most prevalent mode in the screencast and one of the many reasons that screencasts are so popular.

7.4.1. Graphic-Pictorial

The graphic-pictorial mode represented in the screencast included a wide variety of visual elements. Some of these such as photographs, illustrations, charts, videos, and animated graphics/simulations were visual representations of the concept in question, while other visual elements were used in the composition of the screencast as instructive tools. Hallewell & Lacković’s (2017) taxonomy of semiotic referencing for the visual elements was a useful tool to consider the meaning-making potential of the graphic-pictorial elements. The majority of these were unprobed representations of the concept, where the lecturer either features the visual in their narrative (depictional) or does not mention the visual at all (attentional) though it is present on the screen. There are some examples of semiotic articulation (ibid), where the lecturer references the image or elements within the image as part of their teaching. Kress & van Leeuwen (2006) argue that visual communication is always coded. The examples within the screencasts provide us with an insight into the lecturers’ pictorial interpretations of the concept (Lacković, 2020) e.g., *“a low-fi graphic for what a corporate internal network would look like”* (**Robert, Business Lecturer**) and the message they wish to communicate (Kress & van Leeuwen, 2006).

However, the analysis of the graphic-pictorial elements of the screencasts revealed only three examples of semiotic invitation, i.e., the lecturer invites students to interrogate some or all of the image and related meaning, and no critical semiotic exploration. Hallewell and Lacković (2017) contend that this is where the image-concept inquiry can contribute to students’ understanding. The meaning-making potential of the graphic-pictorial elements could be examined to reveal their relationship with the concept, developing students’ critical graphicacy skills (Lacković, 2020). I argue that these skills should also be developed amongst those who design resources for use in education. This was particularly evident during the IG analysis with lecturers, who questioned their own selection of pictorial representations of the

concept, when they were guided through the IG process. One example stands out:
Martina, Academic Student Support Lecturer:

"I never looked at it [image included in external video] in detail, to be honest with you. I looked at the content of the thing around plagiarism. And the images were there. And it was nice. The music, I wouldn't even put that with it. But whatever reason whoever made this video, they chose to put that in. But now when I look back at those sort of things, thinking it's outdated, it's not connecting with the students that I teach".

Through guided inquiry and critical reflection on the meaning-making potential of the images in the screencast, the lecturer acknowledged that the message could be encoded quite differently to their intention because of the visual representations chosen. For those involved in lecturer professional development, this is significant. Lecturer-designers need to identify "the intent and the intentionality" (Lacković, 2020, p. 109) i.e., the origins of the visual representations they include in their digital resources. Additionally, they need to consider these graphic-pictorial representations in the context of the concept they are teaching and critically reflect on whether the intended message is accurately represented within the pictorial signs. Are they allowing for the plurality of possible meanings that can emerge from the choice of a particular digital image? Could they use these visual representations to encourage students to engage critically with the concept and consider the multiplicity of concept meanings (Lacković, 2020)? I contend that in this world of hyper-visuality (Lacković, 2020) there is a greater need than ever to critically engage with graphic-pictorial signs.

7.4.2. Linguistic

The linguistic mode within the MMI focused primarily on the use of language conventions related to teaching within the discipline. Disciplinary knowledge was embodied in many of the screencasts through the use of specific disciplinary language, by "qualified participants in a subject culture" (Nestlog, 2019). In much the same way as the community of experts determine the system of concepts (Lacković, 2020) within the discipline, content experts agree on conventions in relation to subject content vocabulary, to communicate the concepts within the discipline. However, this is often an unspoken part of teaching, and some lecturers did not give it much thought during the design of the screencast. As one lecturer remarked:
"I don't give them a separate vocabulary or anything, but I think, […] it's iterative. And as you go along through the module, they learn, you know there's new terms, new things that you just learn them as you go along." (**Sandra, Engineering Lecturer**).

Several lecturers were mindful of the difficulty associated with learning *"the vernacular of the industry"* (**Robert, Engineering Lecturer**) and conscious of students' struggle to grasp the meaning of these terms, in particular where they may have encountered similar terms in another discipline, but with a different meaning.
Using spatial and temporal sequencing in the multimodal screencast, students could make cognitive links between the pictorial representations and the associated disciplinary vocabulary. This was particularly important where several acronyms were used, e.g., in the screencast on *Local Area Networks* (TCP IP, LAN, DNS, etc.). As they move beyond legitimate peripheral participation (Lave & Wenger, 1991) to become full members of their academic community, they acquire a new vocabulary and adopt the language conventions of the discipline. The screencast, as an extension of the lecturer's teaching, provides students with additional context-based examples of these language conventions of the discipline.

The second object of focus within the analysis of the linguistic mode was the use of language to exemplify a relational teaching approach. This was evident from lecturers' socio-emotional competence and their discursive relationship with their students, yet in many cases it was a subconscious decision. The experience of educators during remote emergency online teaching pointed to a greater awareness of the need for a relational pedagogy and a gradual move away from a neo-liberal marketized HE system (Gravett et al., 2021). Within this present study, the screencasts and qualitative interviews provided several examples of the implementation of a relational pedagogy. From a detailed examination of lecturers' discursive relationship with the viewers, it emerged that many adopted a partnership approach within the screencast, i.e., they situated themselves alongside the learners, engaging with the concept and trying to see it from the students' perspective, while others addressed the student directly, fostering an inquiry-based model of instruction (Archambault et al., 2022) by encouraging them to actively engage with the content. Though there were examples of didactic teaching within the screencasts (e.g., *Microbial Bioplastics*), in the follow up interview this lecturer clearly demonstrates an awareness of the affective nature of learning and provides examples of how emotionally invested students can be e.g., *"crying in class […] they find it really upsetting"*. The lecturers involved in this study clearly valued their relationship with the students and their "relational intention" (Adams, 2018, p. 127) was evident in their explained teaching approaches, with some focused on how they could help students grow by including how they could make a difference within the screencast, e.g., *"you can help stop this cycle of negativity, this*

cycle of withdrawal and emotional distress" ([Timestamp: 5:40-5:49] *The Psychological Effects of Hearing Loss*). Highlighting students' contribution to society e.g., how they might find solutions to the environmental crisis (*Microbial Bioplastics*) reminds us of the core values of the university, which looks beyond the managerial approach to higher education to focus on the betterment of humanity (Lynch, 2006).

It is worth noting that in general, class sizes are small (<60 students) for most lecturers involved in this study, which may make it easier to build a relationship with students. It may be more difficult to include in HE institutions with very large cohorts of students. Yet, it would seem that a partnership approach, which promotes a collaborative approach to learning (Garrison et al., 2000), and acknowledges learner agency in the process (Archambault et al., 2022) contributes to a more engaging learning and teaching experience.

7.4.3. Aural

The aural (voice) mode seemed to be the most important mode for half the participants in this study. As one lecturer put it, "*it (the message) wouldn't have the same impact without the voice*" (**Aoife, Science Lecturer**). The key benefit of including their voice was that lecturers could use prosodic features such as tone or emphasis, e.g., "*you can **break** this cycle of negativity*" ([Timestamp: 5:49-5:51] *Psychological Effects of Hearing Loss*) to underline the importance of the concept. During the guided inquiry activity, some lecturers stated that they used their voice in a purposeful manner to communicate their teaching (e.g., *Psychological Effects of Hearing Loss*) and vocal melody was very evident in many of the screencasts. The "semiotic force" (van Leeuwen, 1999, p. 106) evident in the variation in pitch ranges revealed the forcefulness of the message in the screencast (e.g., *Microbial Bioplastics*) while the use of a melodic phrase (ibid) provides further insight into the lecturers' semiotic articulation of the concept. A legato style is evident in the screencast on *Matter*, where the cadence of the lecturer's voice is consistent and has a continuous flow. This is contrasted with the screencast on the *Psychological Effects of Hearing Loss*, which includes several staccatos to emphasise the message.

The use of discourse markers by some of the lecturers contributed to the speech act (van Leeuwen, 1999) and enhanced the message they wished to communicate. 'So' was used frequently by lecturers as a structural marker (*Microbial Bioplastics*), an opening/closing frame marker (*Food Allergy and Food Intolerance*) or an invitation to engage with the concept (*Matter*), while other examples of discourse markers such as

'okay' (*Psychological Effects of Hearing Loss*) and 'well' (*Microbial Bioplastics*) were also evident.

There is significant benefit to analysing *the voice of teaching* i.e., how the voice embodies lecturers' semiotic practices for teaching. It reveals their epistemological beliefs in relation to the transmission of knowledge and the key messages they are trying to communicate. It may also characterise the emotional style of their disciplinary or social culture (van Leeuwen, 1999) or the need to make students "*[…] think in a different way*" (*Psychological Effects of Hearing Loss*). The semiotic richness of these features is often overlooked in the analysis of the screencast, even in studies which focus on the benefits of audio in teaching such as O'Regan et al. (2016) and Rotheram (2009a, 2009b), or on the voice as a teaching tool (Hämäläinen et al., 2018; Servilha & Costa, 2015).

Though some lecturers were uncomfortable listening to and reflecting on their voice within the screencast, they acknowledged its potential as a semiotic resource. This critical reflection on the semiotic affordances of the voice happened during the guided inquiry activity, highlighting the value of including guided multimodal inquiry in teacher professional development, in particular where the design of learning resources is a key activity.

Perspective (van Leeuwen, 1999) is revealed in the use of music within the screencast on the *Psychological Effects of Hearing Loss*, as the music alternates between the background (alongside the narration) and the foreground (no narration). The hierarchy of voice, music with lyrics, and instrumental music in the screencast above points to Joanne's semiotic awareness of voice and music to construct meaning. Similar to voice, we can consider the contribution of the characteristics of music, such as tempo, rhythm, and semiotic force (van Leeuwen, 1999) to the teaching of theoretical concepts (Rozinski, 2015). The analysis of music as a semiotic resource also reveals both Martina's and Joanne's intentions to evoke an affective response in their students, potentially tapping into students' memories of similar music and creating mental associations with the concept in question (Levitin, 2006).

7.4.4. Spatial-Design

The enactment of software affordances is apparent in the multimodal screencast where lecturers use a combination of digital technologies to create their digital lecture. Given that the lecturers involved in this study had successfully completed an accredited module on Technology Enhanced Learning, a high level of digital literacy (JISC, 2010)

and digital fluency (Miller & Bartlett, 2012) could be expected. This was indeed the case for the most part. However, it was interesting to note that some lecturers did not generally consider themselves very adept in using digital technologies, with one lecturer using the phrase *"technologically challenged",* (**Aoife, Science Lecturer**), yet her screencast provided evidence of considerable digital literacy (Almås & Krumsvik, 2007). Some spoke of struggling with the screencasting technology, while others embraced the affordances of Camtasia to enhance their presentation of content. During the interviews it emerged that lecturers were quite astute in their choice of digital technologies to achieve their pedagogical goals.

Competent in the selection *and* use of appropriate digital technologies to communicate ideas, many of these lecturers have the professional digital capacity (National Forum for the Enhancement of Teaching and Learning in Higher Education, 2016) required for today's digital world. PowerPoint was the presentation software of choice for most lecturers presenting a theoretical concept and the use of this semiotic technology (Zhao & van Leeuwen, 2014) provided them with opportunities to create a semiotic assemblage (Gourlay, 2021), using graphic-pictorial elements and text to explain the disciplinary concept. However, since visual designs (especially screen- based) are non-linear (Kress & van Leeuwen, 2006), i.e., the viewer can choose where to start reading them, some spatial or temporal arrangement of modes is necessary (Conole et al., 2004) to ensure students receive the message in the intended way (Kress & van Leeuwen, 2006). PowerPoint or Camtasia animations are used as a temporal sequencing tool (e.g., *Microbial Bioplastics*), while spatial sequencing is also evident here, through the use of sequential image overlays.

Instructional design principles are also apparent in the use of spatial contiguity, e.g. *"I think they [images and text] work better side by side"* (**Brenda, Engineering Lecturer**), while the Multimedia principle was exemplified in the many instances of using images and words to explain the concept, e.g., in the Screencast on *Food Allergy and Food Intolerance*.

Finally, inclusive education is characterised by the focus on universal design for instruction (UDI) and learning (UDL). The inherent multimodal nature of the screencast adheres to one of the core principles of universal design, i.e., multiple means of representation (Matthews et al., 2022a). Many lecturers also either refer explicitly to UDL or provide evidence of its implementation in the screencast. For example, the screencast on *Matter* exemplifies UDL through its design, choosing an appropriate theme (pastel) and font (sans serif) to increase accessibility. This focus on universal design was a key feature of the professional development programme TEL,

subsequently enacted by lecturers in their digital learning designs. Situating UDI and UDL alongside multimodal semiotic teaching and learning in professional development modules will help educators move towards more inclusive education.

7.4.5. Transmodal moments / transmediation

The transmodal moment described by Newfield (2014) focuses on the many changes that occur as additional modes are used for meaning making. How meaning is translated across modes is dependent on the situatedness of the "semiotic action" (MODE, 2012). A change in meaning, subjectivity, and learning (ibid) can occur, necessitating careful reflection on the part of the designer. Yet, though some lecturers explained why they considered additional modes useful to explain the concept, there was little evidence of lecturers' awareness that the meaning might change across modes. Bezemer and Jewitt (2010, p.187) draw attention to the importance of considering the "gains and losses" of the choice of additional modes and the risk of potential meaning alteration. Each design choice is associated with multiple embedded decisions, and these may be revealed through reflective guided inquiry, to allow lecturers consider the "transmodal semiotic action" (MODE, 2012) in the context of their intended message.

7.5. How is the multimodality of the screencast related to the sociocultural practices of the lecturer and the situated context?

Agency is shaped by the social and cultural factors we engage with (Kahn, 2009) but also by our values, beliefs, meanings, and ideas and influences how we interact with the world. For lecturers in higher education in Ireland, individual agency is shaped by the discipline they teach in, the university they are part of and the national structures, policies and procedures which govern this entity. Trowler & Becher (2001) point to the changing nature of higher education, and in the Irish context, the growing emphasis on the scholarship of teaching (Boyer, 1990) and the role of digital education at a national level (National Forum for the Enhancement of Teaching and Learning in Higher Education, 2015a) are transforming the higher education classroom. Professional development programmes such as TEL embed a theoretical approach to the use of digital technologies (Passey, 2019) in education where lecturers design and develop their digital resources, based on established theoretical frameworks and pedagogical approaches.

7.6. Theoretical & Pedagogical Approaches

Evidence of this from the current study includes explicit references to pedagogical approaches, such as instructional design, which underpin some lecturers' screencast design, while implicit examples of universal design are also evident, e.g. in the screencast on *Matter*. Pedagogical approaches to the development of student knowledge (Jonassen, 1991) through instructional scaffolding were also revealed, such as for **Robert (Business Lecturer**), who explains his teaching approach: *"I would start building up simple things like that"*. This conceptual approach to scaffolded instruction (Doo et al.,2021) is also evident in Engineering, where **Sandra** (**Engineering Lecturer**) introduces the students very gradually to the concepts within the discipline. Lecturers based their screencast design on their pedagogical approaches to maximise student learning, cognisant of the space inhabited by the learner, when they are susceptible to learning (Shawa, 2020). This suggests that the inclusion of theoretical foundations for the use of educational technologies, as outlined by Passey (2019) within professional development programmes is bearing fruit.

7.6.1. Communities of Practice within the disciplines

Particularly evident from the findings was the importance of the academic community within the discipline, which influenced lecturers' approaches to conceptual knowledge development and how this should be scaffolded.

Within the academic disciplines, there are conventions which influence what is considered conceptual knowledge and how this is taught. Trowler (2020) argues that while there are "family resemblances" (p.105) within the disciplines, there is no prescribed set of conventions. However, he does point to "proto-practice reservoirs" (p.106) as potentially influencing discourse and practice within a disciplinary culture, though these are "local, contextually conditioned, and dynamic" (p.107). The findings from this research study support this claim in relation to the modes chosen to represent knowledge within the screencasts. Although they show some common characteristics, it was not evident that these were indicative of their situatedness *within* a specific disciplinary culture. For example, the main carrier of meaning across the range of screencasts varied. The functional load (Jewitt, 2003) was most often carried by the aural (voice) and graphic-pictorial modes, yet lecturers alternated between these two to choose the most important mode or preferred to list both as "semiotic companions" (Tyrer, 2021), noting that each mode added something extra to the meaning of the screencast. The contextual conditioning (Trowler, 2020) of the screencast design points to the individual agency of the lecturer, who draws on the skills and knowledge acquired *externally* through their professional development experience of the TEL module, to supplement their disciplinary knowledge in terms of how the screencast should be designed for students within their discipline.

However, disciplinary conventions are referenced as lecturers explain their teaching approach within their disciplinary culture, with some firmly stating their identity within this culture, e.g. *"I definitely identify as a scientist"* (**Joseph, Science Lecturer**).

Donald (2002) notes the characteristics of the discipline, which includes a specialized vocabulary and an accepted body of theory. The importance of the theoretical base in learning or coming to be (Jewitt, 2009, p.28) is highlighted by several lecturers, whether this was the fundamentals of the concept (**Brenda, Engineering Lecturer**), or the acknowledgement that getting things wrong is an inherent part of the disciplinary culture (**Joseph, Science Lecturer**). This experience is initially challenging for novice members of the scientific community, but a requirement nonetheless for the development of their knowledge and to become active agents within the discipline.

In addition, some disciplinary conventions are challenged. In the screencast on the *Psychological Effects of Hearing Loss* Joanne points to an intentional move away from the *"very scientific"* approach in Year 1, to a different approach in Year 2 and this screencast epitomises the new approach, with a marked absence of scientific language. Sometimes what is not included in the digital lecture can provide an insight into the meaning-making intentions of the lecturer. The absence of a scientific vocabulary was deliberate to focus students' attention on *"real human beings"* (**Joanne, Science Lecturer**) and the impact of hearing loss on their lives. The aim of presenting this "knowledge that informs action" (Biggs & Tang, 2011, p.82) within the screencast is to challenge the way students within this scientific community view the world. Contesting the "structured propensities" (Wacquant, 2005, p. 316, as cited in Navarro, 2006, p.16) and disciplinary norms, this lecturer attempts to embody functional knowledge within the screencast to challenge the students to think differently about their role within the discipline. The progression from Year 1 to Year 2 reveals the lecturers' consideration of knowledge as a process (Deely & Semetsky, 2017) and encourages students to engage with and respond to the screencast sign as it corresponds to their academic and professional lives. This semiotic engagement with the screencast sign is part of the educative process of engaging with and learning from signs situated in life, experience, and educational practice (Deely & Semetsky, 2017, p.216).

7.6.2. Individual agency embodied in signature pedagogies

Kress (2015, p.45) argues that we cannot "get at" knowledge until it is "made material in a representation". Lecturers use the affordances of each mode or the combination of modes to shape disciplinary knowledge, enacting pedagogy as a practice of design (Kress, 2018). This intersemiotic relationship between modes embodied in the screencast reveals lecturers' assumptions about how best to teach the concept in question. According to Shulman (2005) this exemplifies a "deep structure" (p.54-55), one of three dimensions of a signature pedagogy, i.e., a way of teaching within the discipline. An implicit structure (ibid) is evident in some of the examples provided by lecturers (e.g., the importance of inclusivity in Social Science or regulation in Hospitality).

However, academics are constantly reworking disciplinary norms (Bamber, 2012) and the agentic nature of individual teaching is significant as lecturers absorb the knowledge, actions, values, and practices of the wider (academic) community (Meyer & Land, 2005). Through "educational scholarship and research" (Van Dijk et al., 2020,

p.8-9), they draw on the plurality of experiences to add new knowledge to the discipline. Drawing on their semiotic engagement with their semiosphere (Lotman, 1991, as cited in Semetsky, 2010) and their knowledge of "educational design" (Van Dijk et al., 2020, p.8-9) they adopt better ways of representing this knowledge through disciplinary concepts. The examples of teaching approaches embodied in the screencast and described in the interviews point to the evolving nature of teaching and learning regimes (Trowler, 2020) in higher education. The following section outlines some of the main approaches which constitute a signature pedagogy within the discipline, demonstrated in or through the use of the multimodal screencast, to teaching and learning as a sociocultural practice.

Real-world examples help situate the concept within the external context for which students are being prepared and allow students to construct meaning as a social activity through the use of situated examples, such as how food allergies and intolerances are dealt with within the Hospitality sector (*Food Allergy and Food Intolerance*) or how a home computer network exemplifies a LAN for Business students (*Local Area Networks*), or what an electrical diagram *"looks like in the field"* (**James, Engineering Lecturer**). Students can recognise the theoretical concept as it applies to the real world to understand how they should act within this professional domain. The use of graphic-pictorial elements in the screencasts provided pictorial representations of these theoretical concepts, while the addition of other modes further shaped how this knowledge is represented. Through narrating the screencast, the lecturer anchors the meaning and conceptual interpretation (Lacković, 2020) within the students' sociocultural context. Finally, the guided inquiry and discussion with lecturers revealed how their meaning making practices within the discipline are rooted in their own social structures. A comment by **Joseph** (**Science Lecturer**) provides an insight into how he approaches his teaching, i.e., *"there has to be a bit of craic*[2] *[…] well in my world anyway*", while another early career lecturer admits just *"putting out fires"* (**Brenda, Engineering Lecturer**), acknowledging that with experience, they would perfect or enhance their teaching practice.

Through multimodal semiotic analysis of the screencast, socially situated practices can be revealed, whether these relate to the professional context for which students are being prepared (e.g., an awareness of regulatory bodies such as FSAI in Hospitality), or the disciplinary culture within which the lecturers and students operate

[2] A colloquial expression used in Ireland. In this context it is intended to mean fun

(understanding acronyms, specialised vocabulary, or an accepted body of theory (Donald, 2002). In a wider national context, the increased focus on the scholarship of teaching and learning, and developing teacher digital competency is paying dividends, as lecturers become more adept learning-designers.

7.7. What are the implications of the findings for an understanding of online teaching as a relationship between knowledge and its multimodal elements and affordances enacted through digital technologies – how do the two relate?

The following table presents the implications of the findings from this research for an understanding of online teaching. Each of the implications will be further discussed below.

Table 7:1: Implications of the findings for online teaching

Online teaching as a relationship between knowledge and its multimodal elements and affordances enacted through digital technologies	
New ways of organising information multimodally	Applying the MMI: developing critical thinking through the screencast
Lecturers as Learning Designers	Sociomateriality of digital technologies
Screencast as embodiment of teaching and learning approaches	An alternative approach to developing students' conceptual knowledge

7.7.1. New ways of organising information (multimodally)

New digital technologies provide educators with new ways of organising information and generating knowledge (Pinto and Leite, 2020) to facilitate learning. The participants involved in this research study were selected because they had successfully completed a professional development module in Technology Enhanced Learning, in which they created a multimodal screencast. It emerged during the qualitative interviews that they saw significant benefit in using the screencasts in their teaching, and some, such as Sophie and Joanne, admitted they enjoyed using the technology. In some cases, the focus was on the reusability of the screencast and the fact that students could go back and rewind it if they needed to. In other cases, the focus was on the representation of the concept multimodally, and the affordances of the screencast to include multiple modes to represent the concept.

7.7.2. Lecturers as Learning Designers

These affordances also provide opportunities for lecturers to present disciplinary concepts in a variety of ways to cater for an increasingly diverse student population. The flexibility and multiple modalities (Moore, 2007) offered by digital technologies such as screencasting software contribute to a more inclusive educational experience, aligning with the multiple means of representation promoted as part of a universal design for learning approach. Frameworks such as TPACK (Koehler & Mishra, 2009) also challenge educators to consider how concepts can be represented using digital technologies, and how these technologies can help students to overcome barriers to learning to develop their knowledge of key disciplinary concepts. In this study, examples of disciplinary concepts were presented using the medium of the screencast, using established pedagogical and instructional approaches to learning design (Conole, 2013). Conole (ibid) argues that as lecturers' practices evolve, so too do their teaching approach and use of digital technologies. Almås & Krumsvik (2007) suggest that digital literacy in the context of teacher education focuses on the use of digital resources as part of a teaching and learning strategy, and many lecturers involved in this study provided clear evidence of being digitally informed and digitally literate.

7.7.3. Screencast as the embodiment of teaching and learning approaches

Since the screencast is a digital resource often used to support student learning outside of the classroom (Pinto & Leito, 2020), it is useful for educators to know that the screencast embodies their teaching and learning approaches and provides a platform for them to present the concept in a way they feel appropriate to their discipline. The layered multimodal analysis of the MMI framework revealed evidence of pedagogical approaches such as instructional scaffolding, and conceptual or procedural scaffolding (Doo et al., 2021) for either declarative or procedural knowledge (Biggs & Tang, 2011). Some screencasts present declarative knowledge (ibid) e.g., the *Social and Emotional Effects of Physical Activity*, or *Microbial Bioplastics,* while other screencasts present a walkthrough of a software application (*How to get started in Matlab*, *Using Read & Write for exams*, *Relational Databases*), scaffolding the learning for students. In some instances, the lecturer is cognisant of the affordances (and limitations) of the screencast and demonstrates evidence of pedagogical expertise, choosing a particular approach they feel best suited to their students.

7.7.4. Applying the MMI: developing critical thinking through the screencast

Critical thinking is a key objective of cognitive presence (Kanuka & Garrison, 2004) within a Community of Inquiry model. The MMI framework is also a resource for teaching staff to help develop their students' critical thinking skills by exploring multimodal digital resources as they engage with concepts within their discipline. A pilot workshop activity with students provided an indication of the potential for guided inquiry in this regard. While an Inquiry Graphics approach was used rather than the developed Multimodal Inquiry Framework, the insightful answers provided by students suggest that Inquiry Graphics applied to multimodal teaching resources and by extension the MMI are valuable tools in developing students' conceptual understanding and critical media literacy. The focus on individual modes encouraged them to reflect on the affordances of each in the context of their conceptual understanding and learning, while deeper inquiry of the pictorial representations (Lacković, 2020) of the concept challenged them to consider the origin of the image and potential dichotomy between the intended and the communicated message (Kress, 2018). Through this multimodal inquiry, students will develop their critical media literacy skills to help them navigate the post-truth landscape of modern society.

7.7.5. Sociomateriality of digital technologies

Through a lens of sociomateriality, recent research suggests that our relationship with technology impacts our interactions with the world around us. The "constitutive entanglement" (Orlikowski, 2007, p.1437) of the social and material is often ignored in higher education (Fenwick & Edwards, 2016), especially within teaching practice.

For the screencast, the affordances of digital technologies (screencasting software, PowerPoint, YouTube) may influence the design of the screencast, or they may enable lecturers to enact their teaching approaches. Either way, acknowledgement of the sociomateriality of digital technologies challenges educators to consider their engagement with these technologies, not as "disembodied practice" (Gourlay, 2021, p.60) but as the material embodiment of sociocultural practices. For professional development programmes, this adds to the importance of unpacking the semiotic choices inherent in screencast design, facilitated by the guided inquiry within the multimodal inquiry framework.

7.7.6. An alternative approach to developing students' conceptual knowledge

Finally, given the hyper-visuality (Lacković, 2020b, p.443) of our world, and the multiplicity of multimodal signs we interact with, the focus on concept learning through

semiotics and multimodality provides a new approach to conceptual development within the disciplines. While there is much research on the use of multimodality in higher education, it is mainly in the context of media and communication (Kress and van Leeuwen, 2006) or linguistic / language studies (e.g., Early, Kendrick, & Potts, 2015). This thesis explores ways in which the multimodal screencast applies a multimodal inquiry framework, building on an Inquiry Graphics approach that focuses on visual media, to uncover the potential meaning-making intentions of the rhetor (Kress, 2018). This has significance for several reasons:

a) Within the context of professional development, the lecturer as designer becomes aware of their semiotic choices as they design the screencast through a guided multimodal inquiry approach to the creation of digital resources.

b) Since teaching and learning are interconnected and integrated activities, this multimodal inquiry framework could also be used with students. Therefore, students become aware of the semiotic choices of the rhetor, acknowledging the plurality of representations of disciplinary knowledge and developing a deeper understanding of the concept.

c) Guided critical multimodal inquiry helps both lecturers and their students develop their multimodal critical literacy skills.

d) Exploring the affordances of each mode as embodied in the screencast, together with the potential transformation of the message through transmediation and transduction provides the lecturer-designer with opportunities to develop their digital fluency.

This research study set out to examine the screencast through a multimodal semiotic lens, using a multimodal inquiry framework which builds on an Inquiry Graphics approach. The layered approach of the MMI framework provided an opportunity to zoom in on specific areas such as the composition of the multimodal ensemble, and the affordances of individual modes and transmodal moments for multimodal inquiry. A zoom out approach enabled lecturers to reflect on their pedagogical approaches embodied in the screencast and the social structures and socially situated practices which influenced the design of the screencast.

This study concludes that a multimodal inquiry framework can contribute to the teaching of disciplinary concepts, through a multi-layered approach. While the first two

layers examine the multimodal screencast as a semiotic sign, the outer layer explores teaching approaches to knowledge development, which is the focus of this research.

However, lecturers could replace this research object with another disciplinary concept e.g., social justice, climate change, etc. for guided critical inquiry with their own students. The framework encourages an examination of potential multiplicity of meanings of a screencast or video in relation to a key concept and can contribute to the development of students' conceptual understanding through critical reflection.

7.8. Conclusion

This chapter examines the research study in the context of the research questions posed at the beginning of the thesis. Using the proposed multimodal inquiry framework, I answer each of these questions and contend that the framework provides a useful tool to inquire the meaning-making practices of lecturer-designers in the creation of the multimodal screencast.

Chapter 8: Conclusion

This chapter sets out to draw conclusions from this research. It will begin by summarising the key findings in response to the research questions set out at the beginning of the study and will examine these findings in the context of higher education in Ireland. It will propose recommendations for including multimodal inquiry as part of the professional development of those who teach in HE, setting out the originality of this research and its contribution to knowledge as I see it. Finally, a brief summary of the limitations of this study will be included and the chapter will conclude with recommendations for future research.

8.1. Summary of research findings

The overarching aim of this research was to explore how lecturers crafted screencasts to teach specific concepts within their disciplines. In Chapter 1 I set out the background and rationale for this, noting that I consider teaching, learning and knowledge development as multimodal. The following research questions guided the study:

- How can the use of a multimodal inquiry (MMI) framework, developed by the thesis researcher, that builds on an Inquiry Graphics approach, support the teaching of key disciplinary concepts? This question includes the following subquestions:
    - How are key disciplinary concepts articulated through the multimodal ensemble of the screencast?
    - How are conceptual ideas and screencast elements brought together?
- How is the multimodality of the screencast related to the sociocultural practices of the lecturer and the situated context?
- What are the implications of the findings for an understanding of online and screencast-based teaching as a relationship between knowledge and its multimodal elements and affordances enacted through digital technologies – how do the two relate and what does this mean for teaching practice?

The study analysed the screencasts created by 16 lecturers across a range of disciplines within one Irish higher education institution to answer the above questions, using a multimodal inquiry framework developed as part of this research.

The analysis revealed the richness of the screencast as a multimodal semiotic resource and highlighted its potential in the following areas:

1. Multimodality
2. Teaching and Learning in Higher Education
3. Technology Enhanced Learning (and Teaching)

8.1.1. Multimodality

As an educational technologist, I have helped lecturers create many screencasts over the years, but our focus was primarily on the pedagogical approach and design of the screencast, ignoring the semiotic choices of the lecturers in terms of the content, the modes, and the arrangement of the material. However, this study has revealed additional layers of meaning-making within the screencast, through the use of a multimodal inquiry framework. This semiotic awareness is rarely included in courses on technology enhanced learning for higher education teaching and learning, yet it would benefit the lecturer in their role as learning designer. The modal affordances assist the lecturer in communicating their intended message, but the lecturer needs to be aware of what this message is and how it is communicated through the modes they choose. They also need to critically reflect on the material they choose and why they want to include this. The use of the MMI framework for professional development can help lecturers unpack their semiotic choices through guided inquiry.

8.1.2. Teaching and Learning in Higher Education

Traditionally, in our outcomes-based education system, knowledge is considered a product which students will have acquired by graduation. However, more recently there is a resistance to this school of thought, where knowledge is considered as developmental, fluid, and evolving. This has implications for how we teach, since the rigid system of concepts within the academic discipline is challenged as we acknowledge the situatedness of the learner and instead of presenting one perspective on a concept, we invite students to consider alternative perspectives.
This participatory approach to knowledge development increases learner agency and acknowledges their role within the academic community. The use of the MMI as a guided inquiry tool for teacher professional development encourages this pluralistic approach.

Analysis of the screencast using the MMI framework also revealed evidence of lecturers' teaching approaches, in particular relational teaching. While relational teaching became more visible during the remote teaching period of Covid-19, these

screencasts were created several years before the pandemic. This shows the beginning of a change from the neoliberal, marketized HE system to a pedagogy of care, where teachers recognise that building a connection with their students can lead to meaningful learning. Many of the lecturers involved in this study found their own way to build connections with their students, as highlighted in Chapters 5 and 6.

8.1.3. Technology Enhanced Digital Learning (and Teaching)

The wider educational context, both nationally and internationally, has focused in recent years on building digital capacity in education and many initiatives have been developed to support this. The proliferation of courses on technology enhanced learning has provided lecturers with an opportunity to develop their digital literacy. However, we are now seeing a level of digital fluency amongst lecturers, which supports their development as learning designers. They are not just adept at *using* the relevant digital technologies for designing resources, they are also skilled in *choosing* the right digital technologies.

For professional development providers, this offers an opportunity to include additional elements in TEL programmes, such as the multimodal inquiry framework developed as part of this research. This responds to the need to develop critical media literacy amongst students, to decipher the messages in a world saturated with online content. Additionally, it is time to reflect on the sociomaterial nature of digital technologies which permeate all aspects of our lives. In this study, the design of the screencast was influenced by the lecturers' relationship with and knowledge of the digital technologies. While some lecturers went to great lengths to find out how to use a particular digital tool, others changed their teaching approach to suit the technology, highlighting the importance of this "constitutive entanglement" (Orlikowski, 2007, p.1437) for knowledge development.

In terms of the implications of this study for higher education teaching and learning, I propose that professional development programmes should promote a pluralistic approach to the development of conceptual knowledge, recognising the multiplicity of perspectives learners bring to their educational experience. Equally, if we accept that knowledge can be represented multimodally, then we must also embed multimodality into our teaching using videos, images, audio, as well as language to provide a more comprehensive understanding of the concepts we teach. Finally, as university educators become digitally fluent practitioners, TEL programmes should include an additional focus on the semiotic and sociomaterial role of digital technologies for

teaching and learning, given the influence of both on educators' digital choices.

8.2. Contribution to knowledge

This study presents a conceptual framework which focuses on multimodal inquiry for concept development and intersects the fields of multimodality, teaching and learning in higher education and technology enhanced learning as illustrated below.

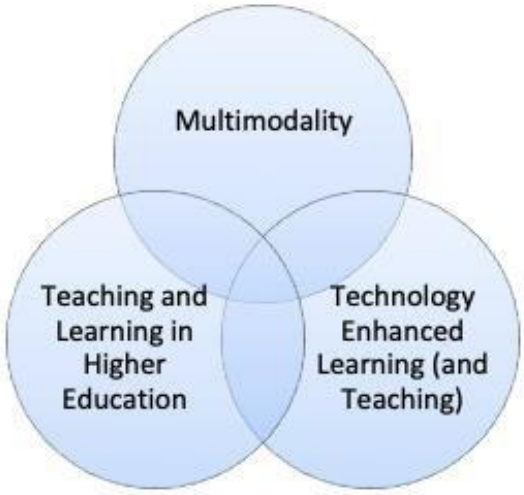


Figure 8:1: Multimodality, Teaching and Learning in HE and Technology Enhanced Learning (and Teaching)

- Multimodality: It contributes to the field of multimodality by extending it to the domain of online and blended higher education, showing how multimodality is embedded in screencast and how it links to HE teaching and learning. While other studies have considered multimodality in HE, the focus is often on multimodal research (e.g., Gourlay, 2010 as cited in Savin-Baden & Major, 2010), rather than developing concept knowledge in a more universal way of applicability across academic disciplines. Here, the focus is on embedding multimodality in learning design.
- Teaching and Learning in HE: I expand the common approach to higher education teaching and learning that is language and symbols driven to add the non-verbal modes (multimodal inquiry) and show how the verbal and non-verbal relate and are used to represent conceptual knowledge.
- TEL(T): this research contributes to the field of technology enhanced learning (and teaching) by showing how online and blended learning can be developed focusing on the screencast lecture, bringing in the dimension of multimodal design. I also show how screencasts can act as a tool for guided inquiry to develop critical multimodal literacy.

8.3. Limitations of the Study

As a qualitative study, the aim of this research was to get a deeper insight into the meaning-making practices of lecturers as they design and use multimodal screencasts in their teaching practice. While I contend that the research design answered the overarching research aim, I am cognisant of some limitations in relation to the study.

8.3.1. Generalisability

Given that the data was collected at one research site / HE institution, it would be imprudent to claim generalisable findings to the broader higher education sector. However, within the cohort of participants, there is representation from a broad range of disciplines, with early career and very experienced lecturers included. In addition, while the disciplinary sociocultural practices may be specific to the institution, the broader structures are similar across the Irish HE landscape, which are governed by similar policies and procedures. To that end I argue that sufficient data was gathered to support the conclusions made in the thesis.

8.3.2. Applicability of the MMI

The multimodal inquiry framework was developed as part of this research study, building on a previously developed Inquiry Graphics approach. While Inquiry Graphics has shown to be a successful tool of inquiry, the final version of the MMI framework has yet to be used with faculty or students. The claim that it is a useful framework for critical multimodal inquiry stems from the extended use of the IG framework with participants in which other modes were investigated for their semiotic meaning, and reference to the literature on multimodality and semiotics. The brief workshop with students showed evidence of the potential of such a framework to unpack multimodal resources, while the qualitative interviews with faculty also pointed to the need for a framework such as this to explore the meaning making practices of those who produce digital resources for an educational context.

8.3.3. Semiotic Engagement

Semiotics is the study of signs. In applying a semiotic lens to this research, I am conscious of my own semiotic engagement with the multimodal screencasts. The analysis of the screencasts necessitated that I bracket my own modal preferences and investigated the screencast as a tool for students' conceptual development. I

continually returned to the qualitative interviews to check my understanding against what the relevant lecturer indicated. Nonetheless, the claim that there is a multiplicity of potential meanings attributed to these multimodal resources also applies to me.
The limitations of a single researcher study are evident here since a research team would have the opportunity to explore the screencasts from their perspectives and provide a more pluralistic analysis.

8.4. Future research

Since my aim from the outset was to find out why lecturers crafted their screencasts in a particular way, the use of edusemiotics and multimodality proved to be an appropriate theoretical framework. Guided inquiry with the lecturers using the IG analysis framework gave me an invaluable insight into their semiotic choices. However, the multimodal inquiry framework that was developed building on the IG has not been introduced to or used with lecturers yet. While it has been presented (and well received) at numerous conferences, the next logical step is to use it with lecturers to see if the proposed framework is appropriate. A model for professional development with lecturers is included in Appendix 4.
The MMI framework may also be further developed to facilitate multimodal inquiry. Additional modes, such as gesture might be included in Layer 1, to analyse multimodal artefacts which include this mode and to explore the associated modal affordances embodied in the digital artefact. Layer 3 may also be adapted to include an alternative research (or teaching) focus. For this thesis, the focus was on knowledge development. However, it is envisaged that other concepts could provide a focal point for critical multimodal inquiry.
Furthermore, the use of the MMI for video analysis in research could provide researchers with a tool to explore how multimodal video is used in a particular context. Finally, the workshop with students using the IG analysis framework was a success in terms of developing their critical graphicacy. It would be interesting to use it in other disciplines to see how the MMI could develop their critical multimodal and media literacy and explore their conceptual understanding through inquiring the modes within the screencast. The guided inquiry activity would focus on one or more modes (it is not likely that lecturers would focus on all four modes) to explore how the concept is presented in the screencast.

Our students live in a multimodal, digital world, saturated with content which at times can be overwhelming. Yet it is rare that they examine the intentionality or analyse the semiotic choices of the creator of these resources, to find out what is behind the message they are communicating. Higher education has a role to play in preparing students to critically engage with this content. Through guided reflective inquiry of digital resources such as the multimodal screencast, lecturers can help them unpack the meaning behind the message.

Appendix One: Grading Rubric for Technology Enhanced Learning

Screencast Criteria	Exemplary	Satisfactory	Unsatisfactory
Screen cast content	The content is appropriate for a screencast and skilfully meets the learning outcomes identified at the start of the screencast. Screencast clearly indicates the breadth and depth of content to be covered.	The content is appropriate for a screencast and adequately meets the learning outcomes identified at the start of the screencast. Screencast indicates the breadth and depth of content to be covered.	The content is not appropriate for a screencast and does not meet the learning outcomes identified at the start of the screencast, or no learning outcomes are identified at the start of the screencast. Screencast does not indicate the breadth and depth of content to be covered.
Screencast Technology; images; graphics & editing	Transitions are smooth, spaced well. Sound quality is at a consistent level throughout. Length of screencast is sufficient for topic. The graphics and/or animations assist in presenting an overall theme and enhance understanding of concept, ideas, and relationships. Content is easily viewed	Transitions are adequate. Sound quality is adequate. Length of screencast is sufficient for topic. The graphics and/or animations assist the audience in understanding the flow of information or content. Content is clear and legible. Content is adequate for viewing	Transitions between different views need refinement. Sound quality poor. Screencast is too long or short. The graphics and/or animations are unrelated to the content and detract from the resource. Content is not clear or legible. Content too small to view easily
Narration	Well presented, smooth delivery in a conversational style using appropriate grammar. Effective enunciation, expression, and rhythm. Volume of voice enhances presentation.	Appropriate delivery in a conversational style. Enunciation, expression, and rhythm appropriate. Volume of voice enhances presentation.	Inadequate presentation. Poor enunciation, expression, and rhythm Voice does not enhance presentation.
Creativity	Screencast is very engaging. Effective use of screencast software	Screencast is engaging Use of screencast	Screencast is not engaging. No use of

	for zoom & pan, for emphasis/highlighting, transitions	software for zoom & pan, for emphasis/highlighting, transitions.	screencast software techniques.
Upload	Uploaded to personal Youtube Channel with relevant descriptions. Link on individual CLE with detailed summary.	Uploaded to personal Youtube Channel with basic summary. Link on individual CLE with adequate summary.	Not uploaded to personal Youtube Channel. Link not on individual CLE or summary not shown.
Pedagogical considerations	Resource is a good example of technology supporting learning & teaching in the context of individual teaching practice.	Resource supports learning & teaching in the context of individual teaching practice.	Resource is an inadequate teaching tool in the context of individual teaching practice.
Comment:			

Appendix Two: Participant Information Sheet and Consent Form

Participant Information Sheet

Title of Project: What lies beneath? Exploring the use of multimodal screencasts for knowledge development in higher education.

Researcher: Geraldine Mc Dermott
PhD Supervisor: Dr Natasa Lacković

Dear participant,
Thank you for your interest in taking part in my PhD research study. Before you commit fully, you need to understand why the research is being done and what it would involve for you. Please take time to read the following information carefully. Talk to others about the study if you wish. Ask me if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

What is the purpose of the study?
The purpose of this study is to investigate Higher Education teachers' understanding of how non-linguistic texts, represented in screencasts, contribute to the development of knowledge within their discipline. This research is part of my PhD studies with the Department of Educational Research at the University of Lancaster, UK.

Why have I been invited?
You have been invited to take part because you work in a Higher Education setting and have created a screencast as part of the Special Purpose Award in Technology Enhanced Learning (TEL).

Do I have to take part?

Your participation in this study is voluntary and you can withdraw at any stage without giving reason and without prejudice.

What will taking part involve for me and what will happen to the data I provide? Outline:

- You will give consent for the screencast you created for the TEL module to be analysed using a social semiotic, multi-modal analytical framework. This will help to identify which mode is foregrounded (text, image, or audio), which mode is a major/minor carrier of meaning and what that meaning is perceived to be.
- You will also give consent for the documentation you submitted with the screencast to be analysed for insights into how the screencast was created and its use for knowledge development within the discipline.
- Finally, you will be invited to take part in a semi-structured interview, which will last approximately 30-45 minutes to discuss the screencast.
- The screencast and the documentation will be saved in a password- protected folder on an Institute computer. The interviews will be audio- recorded and transcribed. All identifying elements will be removed from the transcripts and these will also be saved in a password-protected folder. The data will be only accessed by myself and my PhD supervisor, where necessary.
- Screenshots from participant screencasts would be included in the final thesis, to support claims made. However, identifiers within the screenshots will be removed (for example by using blurring or other editing mechanisms).
- I intend to use such edited screencasts and data from interviews under pseudonyms in research publications and dissemination, such as conferences or articles.
- As a participant, you will be given full access to your stored data if you require.

What will I have to do upon reading this form?
You are requested to inform yourself of the study and sign the consent form (which will be given to you at the start of the interview). You will be invited to share your screencast and documentation and attend the semi-structured interview at a time and location convenient for you.

What are the possible benefits of taking part?
This research will provide you with insights into the use of visual pedagogy in your teaching, through multimodal screencasts and how these may be used to contribute to knowledge development within an academic discipline.

What will happen to the results of the study?
It is my intention to communicate the results of this study at relevant Higher Education conferences and in appropriate publications. It will also inform the teaching within the Special Purpose Award in Technology Enhanced Learning in Athlone I.T. and across the IoT sector.

For further information please contact me gmcdermott@ait.ie.

Thank you for reading this information sheet.

Geraldine Mc Dermott

Title: What lies beneath? Exploring the use of multimodal screencasts for knowledge development in higher education.

I.....□.....voluntarily agree to participate in this research
study.

I □understand that even if I agree to participate now, I can withdraw at any time or refuse to answer any question without any consequences or prejudice.

I □understand that I can withdraw permission to use data from my interview within two weeks after the interview, in which case the material will be deleted.

I □have had the purpose and nature of the study explained to me in writing and I have had the opportunity to ask questions about the study.

□understand that participation involves sharing **the screencast I created for the TEL module***; sharing **the documentation that accompanied this screencast** *and participating in a semi-structured interview.

□ understand that I will not benefit directly from participating in this research.

agree□□ to my interview being audio-recorded.

I □agree to screenshots from the screencast being used (with identifying information removed or edited - these would be for example text, logos or faces) in the PhD dissertation, conference presentations and published papers.

I □understand that all information I provide for this study will be treated confidentially.

I □understand that in any report on the results of this research my identity will remain anonymous. This will be done by changing my name and disguising any details of my interview which may reveal my identity or the identity of people I speak about.

□ I understand that the quotes from my interviews would be used under a pseudonym in order to protect my identity in research outputs, such as a dissertation, conferences, presentations and published papers.

I □understand that if I inform the researcher that myself or someone else is at risk of harm they may have to report this to the relevant authorities - they will discuss this with me first but may be required to report with or without my permission.

I understand that signed consent forms and original audio recordings will be retained in Athlone IT, in a password-protected folder and accessed only by the researcher and PhD supervisor.

I understand that a **transcript of my interview** *in which all identifying information has been removed will be stored in a password protected folder, and retained for 10 years (Lancaster University Data Management Policy).

I understand that under freedom of information legalisation I am entitled to access the information I have provided at any time while it is in storage as specified above.

I understand that I am free to contact the researcher or supervisor to seek further clarification and information.

* Denotes the actual data that will be stored for the purpose of the PhD research.

Signature of research participant

(Signature of participant) -------- ----------

---------- ----------(Date)

Signature of researcher

I believe the participant is giving informed consent to participate in this study

(Signature of researcher) --------- ----------

---------- ----------(Date)

If you have any questions or issues, please ask the researchers upon reading the form, or later, please contact the researcher or research supervisor.

Researcher: Geraldine McDermott, gmcdermott@ait.ie, 090 64 68098.

Supervisor: Dr. Natasa Lacković, n.lackovic@lancaster.ac.uk, +44 (0) 1524 594662

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THANK YOU!

Appendix Three: Inquiry Graphics workshop with students

This vignette describes a workshop with science students using the IG framework to explore the use of multimodal screencasts to develop their knowledge of a disciplinary concept. Ethical approval was granted by the research site to conduct the research with students and pseudonyms were assigned to preserve student anonymity. While the original plan was to facilitate workshops with three groups of students from different disciplines to triangulate the research data, only one of the planned workshops took place, two days before the university closed its doors due to Covid-19.

Participants: 11 Year 3 Science students Screencast: Microbial Bioplastics

Date: 09/03/2020

Following a short overview of the research and the workshop format, students were provided with the IG analysis handout (similar to the handout provided to research participants) and asked to take note of the sections in the screencast that they considered important for learning about the topic. The objective here was to ascertain if their understanding of key aspects of the concepts aligned with the Key Moments (KM) identified by the lecturer. Three of the five KM identified by the lecturer were referred to by students, i.e., the impact of discarded plastic (Key Moment #1[0:24-0:29]), the effects on wildlife (Key Moment #3 [2:53- 2:56), and the Great Pacific Garbage Patch (Key Moment #2 [1:19-1:22]). When asked if the disciplinary language used was familiar to them, one student replied that it was *"language used over the college years in the course"* (**Phillip**), while another acknowledged *"hearing it for the past 2-3 years"* (**George**). Interestingly, this student also suggested that the language was *"understandable but hard to explain to someone else"* showing evidence of navigating the liminal space within the discipline (Ellsworth, 1997).

The second stage of the workshop focused on the IG activity (Lacković, 2020) using one slide which included a collage of images (see below). Students were invited to list (Representamen) what they saw/heard; Describe what they saw/heard (Denotation) and explain what this meant in the context of the concept (Object). The Connotation phase was omitted because of time constraints. Generic items listed were as they saw them, i.e., not simple shapes but beakers, bottles, logo, crates, while specific disciplinary items were also listed, e.g., petri dish, conical flasks, beakers. Their situated knowledge was evident in the Denotation phase, where they described what

they saw: *"plastics used/transported all over the world"* (**George**). Finally, students were asked to reflect on what this meant for developing their understanding of the topic. Their responses indicated they were thinking about the image producer's intentions, e.g., *"images are colourful to engage us"* (**Sam**) and they *"highlight [...] our dependency on plastics"* (**Maria**).

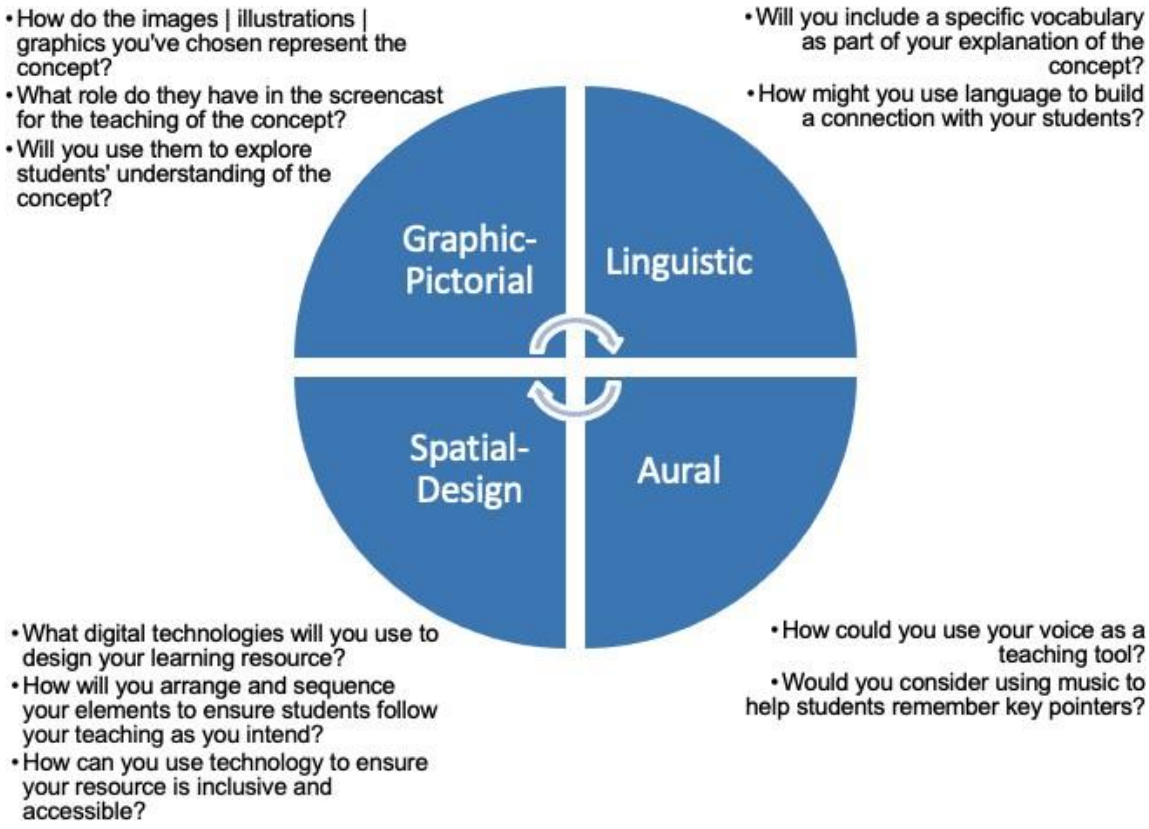
Appendix 3: 1: Slide used for IG activity with students

The penultimate stage of the workshop explored multimodality with the students in terms of the modes present and the perceived semiotic / pedagogic functions and effectiveness of these. Students were asked if they thought any mode (text, image, voice) was superfluous and five students felt the text was not necessary as *"voice and pictures were enough"* (**John**). A question focusing specifically on the voice revealed an awareness of its affordances as it is used to *"emphasise [] different things"* (**Eric**) and *"make [the] listener sympathetic when listening"* (**Sam**). Finally, when asked why it is important to critically engage with images, their answers were quite revealing. Some focused on conceptual links, e.g., the pictures *"show the relationship between plastics and the problems they create"* (**Fiona**), while others examined the semiotic relationship between the images and the producer, e.g., the image *"may be from a source that has other motives or agendas"* (**Anne**).

The final stage focused on evaluating IG as a pedagogical tool to develop their knowledge of concepts within their discipline. The majority felt it was useful, since *"it helps individuals think"* (**Philip**) and some were cognisant of the need to consider the multiplicity of perspectives, *"looking at the images from more than one perspective leads to a better understanding"* (**George**).

Though the number of participants is small, these insightful answers suggest that Inquiry Graphics applied to multimodal teaching resources is a valuable framework to help students' conceptual development. The focus on individual modes encouraged them to reflect on the affordances of each in the context of their conceptual understanding and learning, while deeper inquiry of the pictorial representations (Lacković, 2020) of the concept challenged them to consider the origin of the image and potential dichotomy between the intended and the communicated message (ref Kress, 2018). Through this multimodal inquiry, students can develop their critical media literacy skills to help them navigate the post-truth landscape (Lacković, 2019) of modern society.

Appendix Four: A proposed teaching model for creating screencasts using the MMI framework



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