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Transitioning between 'Outside' and 'Inside' Knowledge in an Online University EMI Chemistry Course

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Recent studies in applied linguistics research have focused on how teachers draw on 'outside' knowledge relating to students' everyday life for the purpose of teaching subject matter content. This study focuses on such practices in the context of English-medium instruction (EMI) higher education in an online undergraduate chemistry module. Adopting an interdisciplinary perspective, the study combines multimodal Conversation Analysis (CA) and the Autonomy dimension of Legitimation Code Theory (LCT) to examine how one lecturer shifts between 'inside' knowledge of chemistry and 'outside' knowledge for a range of different purposes. Multimodal CA is used to carry out micro-analyses of epistemics and identity-related positioning in interaction, while LCT 'autonomy codes' are used to trace knowledge-building trajectories in which knowledge is positioned inside or outside the target topic and is used for different purposes. The analyses highlight how the lecturer skilfully deployed a range of semiotic resources in transitioning between 'inside' and 'outside' knowledge, and how these resources were leveraged for the building of disciplinary knowledge. Implications of this interdisciplinary approach for research and practice in university EMI contexts are discussed.

1. INTRODUCTION

In higher education institutions (HEIs) in non-Anglophone countries throughout the world, there is an increasing trend towards the provision of academic programmes taught through the medium of English (English Medium Instruction, or EMI). This trend is driven by a perceived need for greater internationalization, in terms of recruitment of international students and providing future career opportunities for 'home' students and staff, and the generally held belief that English is the international language of science and academia (e.g. Muthanna and Miao 2015). The rapid growth of EMI provision has meant that there is an increasing need for a research-based understanding of its possible benefits and drawbacks, its outcomes, and of the social, educational, and communicative conditions of its implementation.

In a systematic review of the EMI literature, Macaro *et al.* (2018), pointed out that much of the existing research focused on participants' perceptions and beliefs, but there was a lack of research on classroom interaction in HE EMI contexts. However, since then, and perhaps spurred on by this reminder, there has been increasing research attention to what goes on in interaction in HE EMI classrooms, and interactional studies on HE EMI classrooms have begun to focus on an increasingly wide range of issues. A brief survey of recent studies shows attention to teacher questioning practices (Genç and Yüksel 2021), the relationships between L1 use, interaction and pedagogy (Şahan *et al.* 2021), and translanguaging (Kao *et al.* 2021). Among recent developments, one which is of particular relevance to the current study, is the growing focus on multimodality, that is, a focus beyond language to include other embodied meaning–making resources such as gaze, gesture, and body orientation, as seen in studies such as Duran *et al.* (2022).

One issue in classroom interaction studies which has not received much attention in the HE EMI context is that of how teachers draw on types of knowledge from outside the current academic topic which is the target of learning. In literacy studies in education, there is a research tradition on how lecturers can use learners' 'funds of knowledge' (the resources and lived experiences of, particularly, working class families) as a classroom resource for learning (e.g. Moll 2019). Such work aims to show how lecturers can connect learners' worlds of lived experience with the classroom, both by bringing the 'outside' in and applying the 'inside' outside the classroom (Teo 2008). Within applied linguistics, there has been a focus on how what Zimmerman (1998) labelled as 'transportable identities' (identities such as mother, teenager, pet-owner, music fan, etc.) which go beyond classroom 'situational' identities (teacher, student) can be activated in classroom interaction as resources for learning (Richards 2006). The participants (teacher/lecturer and students) may be positioned epistemically regarding these identities in talk-in-interaction. While the students are regarded as holding a less knowledgeable position through situated identity, they are assumed to be more knowledgeable (Heritage 2012) when drawing on their transportable identities based on outside knowledge in their lives (e.g. Waring 2013).

EMI studies carried out in secondary school contexts have focused on connecting the world inside and outside the classroom. Lin (2015) provides a framework for bridging multiple resources by connecting everyday oral and spoken language with academic oral and spoken language across L1 and L2. Lin and Lo (2017) show how a teacher draws on his students' everyday knowledge of cultural practices in their community and translanguaging to bring a science topic to life. Tai and Wei (2020) use multimodal CA to explore how a secondary mathematics lecturer 'brings in the outside' by creating real-life scenarios and using an everyday life metaphor through translanguaging practices.

However, these studies in EMI which have focused on integrating the world outside the classroom with classroom learning have focused on school learning contexts. There is a need for such studies in the HE EMI context, as bringing in the world of outside experience is also relevant to EMI lecturers' practices. Another gap which the current study aims to address concerns the fact that 'bringing the outside in' in most studies only relates to non-academic 'real-life' experience. It does not include the practice of drawing on other academic knowledge, either from within the same discipline or from other subject areas. Lecturers may attempt to facilitate understanding by relating a concept to another area of the curriculum in the same discipline, or show how it may be applicable to, or understood in terms of, another field of academic knowledge. Such practices can also be considered in terms of their effectiveness in building students' knowledge, as not all 'bringing in the outside' may lead to optimal outcomes, either in the short term in relation to how classroom interaction plays out, or in the longer term, in facilitating achievement in the discipline. This study aims to address these gaps by focusing on an online chemistry classroom in an EMI HE context in Turkey, and by combining Multimodal CA with a sociological framework (autonomy codes from Legitimation Code Theory) which allows for both a close-up exploration of embodied meaning–making practices and an analysis of their potential pedagogical effectiveness for knowledge building. In this regard, the study is guided by the following research questions:

- How does a lecturer draw on outside knowledge to introduce the targeted content using different interactional practices in his talk in an online EMI chemistry classroom?
- How is outside knowledge used for disciplinary knowledge building purposes in an online chemistry classroom?

2. LEGITIMATION CODE THEORY: AUTONOMY

Legitimation Code Theory (LCT) is a sociological framework which offers a set of conceptual tools for the exploration of knowledge-building practices in educational and other fields (Maton 2014). These conceptual tools are grouped into a set of dimensions, which allow for the exploration of knowledge-building from different perspectives. In current LCT research, the three dimensions which are most active are Specialization, Semantics, and Autonomy. Specialization focuses on two types of relations, epistemic (an emphasis on knowledge), and social (an emphasis on knowers), allowing for a conceptualization of knowledge practices as 'knowledge', 'knower', and other codes. Semantics looks at knowledge practices from the perspective of meaning, with two key concepts—semantic density and semantic gravity. Semantic density refers to condensation of meaning in words or symbols, and semantic gravity sees meaning as more or less embedded in context. As this paper deals only with Autonomy, we expand on this dimension below, and we make no further reference to Specialization or Semantics.

The LCT dimension of Autonomy is concerned with the ways in which different sets of practices are seen as having boundaries which insulate them from each other. It explores how the different constituents of practices, which can include 'actors, ideas, institutions, machine elements, body movements' (Maton and Howard 2020: 96) can be related together in different ways. Any constituent can be seen as belonging to a practice which is strongly cordoned off from other practices, or as belonging to a more porous set of practices in which movement across boundaries is relatively free. Not only are constituents positioned in this way, but they are also positioned relationally, for example, in the purposes to which different constituents are put. Thus, positional autonomy (PA) is concerned with how constituents are placed within one context or category or in other, more, or less related, categories, and relational autonomy (RA) refers to how relations among constituents in one context or category are more or less isolated from relations among constituents in another context or category. Both types of autonomy can be seen as stronger (PA+, RA+) or weaker (PA–, RA–) and when drawn as two intersecting axes, they form an *autonomy plane* which yields four distinct *autonomy codes* (Figure 1).

In *sovereign codes* (PA+, RA+), what is valued are constituents and purposes generated from within the practice. To use the example of the context of this article, in teaching chemistry, only chemistry concepts, symbols, and objects and only the purposes of building knowledge of chemistry would be valued. In *exotic codes* (PA–, RA–) ideas, concepts, or actors belonging to other contexts or categories (the 'outside') are the focus of attention, and the purposes for focussing on them also come from 'outside'. In our chemistry example, this could be the lecturer telling a story or anecdote that has no obvious connection with the chemistry topic under study, and which is used for some other purpose, such as engaging or entertaining the students. With *introjected codes* (PA–, RA+),

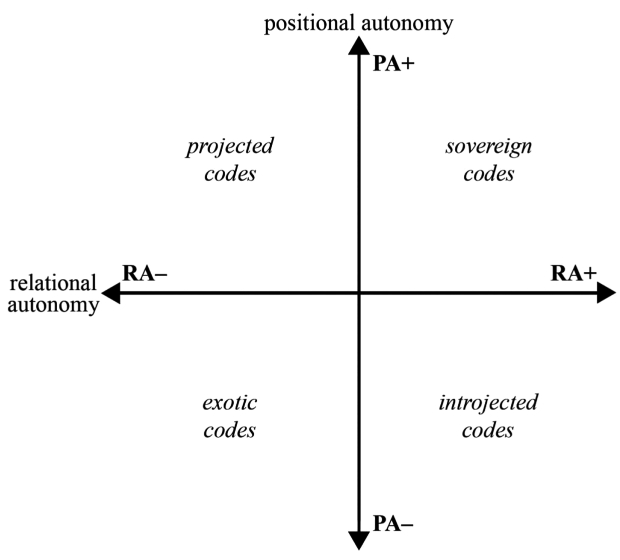

Figure 1: The autonomy plane (Maton and Howard 2018: 6).

constituents from outside the current context or category are valued, but they are used for purposes that come from within that context or category. Here, the chemistry lecturer might draw on students' knowledge from outside chemistry (their 'everyday' knowledge), but this would be for the purpose of learning the chemistry topic in question. In *projected codes* (PA+, RA−), value is given to constituents from within the practice, but the purposes come from outside. This code would apply if a chemistry lecturer used chemical concepts, symbols, and objects for a purpose other than learning chemistry (e.g. by focusing on food and cooking).

The four codes are not a rigid framework, but a topological space through which knowledge-building practices can move. Any teaching episode is unlikely to stay for very long in one code. What generally happens is that there are shifts from one code to another that trace trajectories which can be described as *autonomy pathways*, which can take the form of *one-way trips* or *tours* (Maton and Howard 2020: 98). One-way trips occur when there is a move from one code to another without going back to the starting code. Autonomy tours start out in one code, then pass through one or more other codes, before returning to the starting point. From the point of view of EMI lecturers drawing on knowledge from the 'outside', the notion of autonomy tours can provide analysts and practitioners with a powerful set of tools to identify, describe, and improve their practices.

However, for these powerful analytic tools to be used effectively in any analysis, it is necessary to show how they are applied to the specific context under study. This requires the use of a 'translation device' (Maton and Howard 2020: 98), which allows the analyst to relate the conceptual categories from the LCT dimension of autonomy to the actual empirical data. Translation devices can be created for a specific object of study, or can be more generic in that they can be employed across a range of contexts. For this study, we adapted the *generic translation device* described in Maton and Howard (2020) to the current context.

The device shows how the abstract LCT concepts of relative strengths of positional and relational autonomy (PA+/−, RA+/−) are 'translated' into categories which are relevant to the context under study and the data being analysed. At the first level, constituents can be analysed as *target* or *non-target*, depending on whether they are generated from within or outside the practice being focused on. At the second level, target constituents can be analysed as *core* or *ancillary*. In the context of this study, core constituents are concepts, objects, or symbols from the chemistry topic under study, and an *ancillary target* would refer to other constituents from within the chemistry curriculum, but not the current topic. Non-target constituents are either *associated*, for example, content from other academic disciplines (possibly another science discipline in the chemistry example), or *unassociated*, such as when a lecturer draws on non-academic 'outside' content. The generic translation device for autonomy can have a further level, but as Maton and Howard (2020: 99) point out, the number of levels used depends on the specific research focus. In this study we found that the two levels described here (Table 1) had sufficient explanatory power to address our research questions.

Table 1 : Translation device for the data analysed in this study

PA/RA	First level	In this study:	Second level:	In this study:
+	*Target*	Undergraduate chemistry: Spectroscopy	*Core*	Specific topic on spectroscopy and molecular structure of compounds
			Ancillary	Other topics in the chemistry curriculum
		Other contents or purposes	*Associated*	Other scientific knowledge (medicine, biology)
–			*Unassociated*	'Outside' knowledge from beyond education (e.g. devices used at home)

It can be seen, then, that the use of the autonomy dimension from LCT, and the translation device, provide a set of analytic tools which have the potential to generate a greater understanding of the place of drawing on 'outside' knowledge in educational practices such as EMI chemistry.

3. DATA AND METHOD

3.1. Data and research context

In the current study, the broader database comes from more than 13-h of video recordings of online classroom interaction from an 'Introduction to Organic Chemistry' course in an EMI HE institution in Turkey. The online classes were observed and video-recorded for 9 weeks during the spring semester of the 2020–2021 academic year. The focal compulsory course was offered to 20 second grade undergraduate students in the department of Chemistry. The Turkish lecturer was an experienced associate professor with 7 years' teaching experience in the university from completing his PhD degree in the USA. While teaching the Introduction to Organic Chemistry course online, he connected to the online Zoom meeting with two accounts: he not only displayed the chemical formulas on the coursebook through the shared screen of his iPad, but he also explained some chemical reactions through real materials (e.g. carbon elements) to the camera thereby sharing his own view. The focal data of this single-case study comprise around 2 h of online video recordings taken from the fifth week of this online EMI course. Before the data collection process started, ethical approval was received from the research ethics committee in the university, and consent forms were signed by the participants. Pseudonyms were used to assure the anonymity of the participants.

3.2. Method

This study first adopts Multimodal Conversation Analysis (CA) (Sacks et al. 1974) to investigate how the participants enact verbal statements, multimodal actions, and materials to co-construct the targeted online EMI classroom content (e.g. Duran and Sert 2019). As a data-driven research methodology (e.g. Sidnell and Stivers 2013), CA allows researchers to closely examine locally situated, naturally occurring interactional organization of the online content teaching and learning environment from the social and participant-relevant (emic) perspective (Markee 2013). In line with the main principles of CA (Seedhouse 2005), the data analysis process of the study started with the collection of video-recorded naturally occurring data to explore the systematic orderliness of the interaction. Then, the video recordings were viewed several times through ‘unmotivated looking’ (ten Have 2007) without any predetermined theoretical accounts or assumptions about the data. Thirdly, all the video recordings were transcribed using Jefferson’s (2004) and Mondada’s (2018) CA transcription conventions to capture all the verbal and embodied details of the online classroom interaction (see Supplementary Appendix). Then, line-by-line analysis of sequences was carried out with the examination of turn-taking, sequence and preference organization, and repair. Finally, a collection of the repeated cases was built to showcase the particular phenomenon of interest in interaction: displaying outside knowledge and shifting from academic to outside knowledge through different interactional practices including question-answer (e.g. Koshik 2002), and displays of epistemic knowledge (Heritage 2012) thereby positioning the participant identities (e.g. Richards 2006) while focusing on the targeted classroom content. The collection for the current study consisted of six cases coming from six weeks of the focal course, with each episode lasting for around 8 min.

Multimodal CA explores the process of learning through the micro-analytic understanding of classroom interaction, but it does not portray a product of learning or any change in cognitive states of learners (Seedhouse 2022). Whereas purist CA researchers emphasize learning behaviours and objects within moment-by-moment interaction (e.g. Markee and Kunitz 2015), developmental CA scholars aim to explore the development of interactional competence, and frame their analytic findings (e.g. change in participation) as evidence of learning (e.g. Brouwer and Wagner 2004). Therefore, developmental Conversation Analysts ground their in-depth investigations on exogenous theories such as sociocultural theory (e.g. Mondada and Pekarek Doehler 2004) right after they have documented co-constructed classroom interaction. Although these studies have attempted to explore the product and process of learning through micro evidence of change in learning status, there is a lack of studies that focus on the complexity of participants’ knowledge-building practices. In this regard, LCT can be adopted as an exogenous theory to investigate the dynamic transition of knowledge-building process as a sociological theory of knowledge (Maton and Howard 2020). Particularly, the Autonomy dimension of LCT may allow researchers to obtain a deeper understanding of connecting outside (non-academic) knowledge with academic knowledge and making transitions between different knowledge-building actions through the notion of autonomy tours. However, LCT studies have generally highlighted the abstract representation of knowledge building process of interlocutors and have relied less on the micro analysis of naturally occurring data.

In adopting an interdisciplinary approach which combines Multimodal CA and LCT, the current study combines two theoretical and methodological frameworks which might at first glance seem to be antagonistic. Multimodal CA has its roots in ethnomethodology (Heritage 1984; Garfinkel 2002), an approach which favours interactional reductionism, which sees interaction as the foundational social reality, and all individual and structural phenomena derived from this notion (Sawyer 2005: 200). As such, it may be seen to contradict the social realism of LCT, which sees knowledge practices as '*both* emergent from *and* irreducible to their contexts of production—the forms taken by knowledge practice in turn shape those contexts' (Maton 2014: 11, emphases in original). The use of CA in this study is, as explained above, developmental in that it combines CA with an exogenous theory which does not share a 'purist' ethnomethodological commitment to interactional reductionism. However, similarly to purist CA, developmental CA initially follows a line-by-line sequential analysis from an emic perspective. Then, while combining micro analytic findings of CA with an exogenous theory, the same extracts were re-analysed using the autonomy dimension of LCT. From an LCT perspective, interdisciplinary work is important precisely because theoretical perspectives are different. For example, in the case of the rich collaboration between LCT and systemic functional linguistics, the two disciplines are not seen as melting into each other, but as being separate and distinct with each theory offering 'different insights which are complementary, and which together can offer greater explanatory power' (Martin *et al.* 2020: 26). As these authors point out, it is crucial to conduct the analyses using the two frameworks separately before bringing them together, and this is the approach adopted in this study.

During the data analysis process, the current study first uses the data-driven and bottom-up research perspective of Multimodal CA to explicate how the lecturer displays outside knowledge, and makes transitions between outside and academic knowledge through different interactional resources in the focal EMI setting. We then re-analyse each episode using the Autonomy dimension of LCT, to show the different trajectories through which knowledge from within and outside the target topic is used for a range of knowledge-building purposes. Following Schegloff (1987), we present a representative single case analysis to show how this interdisciplinary approach reveals the locally situated moments of transition as well as the principles underlying these knowledge-building practices. In brief, the combination of Multimodal CA and LCT offers a rich interdisciplinary perspective on dealing with the complexity of micro analytic findings of the focal classroom and participants' knowledge-building practices, both as interactional phenomena and as constraints on what happens in the locally situated interaction. In the next section, four interconnected extracts from the same single case are closely examined using Multimodal CA and LCT respectively.

4. FINDINGS AND ANALYSIS

4.1. Multimodal conversation analysis

In this section, the four interconnected extracts will be closely examined to demonstrate how the lecturer utilizes outside knowledge through various interactional practices such as different question formats and identity positioning as he goes over previously presented content and proceeds to develop the topic (ionizing radiation-ir) from the previous week. Extract 1 shows how the lecturer attempts to elicit the prior learning from the students using diverse question formats and chemistry-specific terminology.

Extract 1: ir spectroscopy

```
01   Lec:  so what is this method tha:t (.) that helps us to determine
02         u:r different functional groups in u:r in organic compounds?
03         (0.6) a:nd inorganic compounds also
04         (1.8)
05   S1:   inference [e:::r
06   Lec:  ir        [spectroscopy:
07         +↑yes+ (0.4) ↑yes s1 (.) thank you: yeah inference
     lec   +--1-+          1: nods his head
08         spectroscopy right? .hh ur so: this: (.) this region
09         e:r where this vibration occu:r (.) it ↑ma:tches
10         with the:: er spectrum of i:r: radiation (.) you just go
11         from ↑four hundred base number to four thousand base
12         numbers hh e:r but that region valued ir spectroscopy
13         (0.7) e::r +↑mo:re energetic light+
     lec              +---------2------------+ 2:moves his hands to the left
14         is used for which spectroscopic method?
15         (1.4)
16         so:: e::r you have (.) ↑u v: (0.4)
17         you have %visible (.) then you have ir: right?
18         +(1.2)   %: screensharing stops
     lec   +--3-> line 20          3: Lec reshares the screen
19         so: u:v: vis: (0.5) do we we: do we use uv: vis
20         for any:: e:r a- any spectroscopic methods?+
     lec   -------------------------------------------+
21         (2.0)
22         uh the answer is y↑es and it's called uv vis spectroscopy
23         ehe heh $oka:y?$ so uh you know e:r the spectroscopy
24         that you do in that region of ↑light is called uv vis
25         spectroscopy: the region that you do: with i r: is called
26         ir spectroscopy so it just ↑tells you which light
27         (.) er which light >that you're actually<.hh
28         ↑using (0.3) .hh and then e:r uv spectroscopy
29         >what do we< observe (0.4) we observe an
30         +↑absorption band right? we u:r we see
     lec   +-----------4----------------------->   4: waves his hands
31         an absorption band+ we just see whe:re the
     lec   -----------------+
32         visible light or uv light is absorbed
33         e:r and that just helps you to determine
34         actually the ↑band energy (.) so
35         +what is your ↑highest occupied >molecular
     lec   +------------------5--------------------> 5: raises his hands
36         orbital<+ (.) in that molecule (0.8) and
     lec   --------+
37         what is +the lowest+ unoccupied >molecular
     lec           +----6-----+  6: raises his right hand
38         orbital< (0.3) a:nd what i:s (.)
39         +this distance in between them? this distance
     lec   +--------------------7-------------------->
               7: moves his hands up and down
40         is importa:nt for  the  homo and lumo level+
     lec   -------------------------------------------+
41         separation is important (0.4) .hhh
42         e:r for ↑what (.) property of compou:nds?
43         (3.1)
44         maybe if i: (.) call them +valence band and
     lec                             +------8--------->
                   8: lowers hand, palm facing downwards
45         conduction band+ (0.5) instead of +homo and lumo+
     lec   ---------------+                  +-----8--------+
46         (0.3) e:r it would make more sense
47         (1.5)
48         which property is determined by: this separation?
49         (1.7)
50         their ↑color (.) is determined by their separation
51         (0.3).hh and also their conductivity: (0.5) is determined by
52         this separation (0.4) oka:y?
           ((25 lines omitted.)) ((Lec explains the separation of homo and lumo energy levels.))
78         >you know< uv vis (0.4) is used for homo lumo (.)energy
79         levels: .hh and then i: r: is for all the vibrations
80         stretches bends and stuff .hh and then you go to
81         +even mo:re (0.5) even less energetic+ ↑light which
     lec   +-----------------9------------------+
              9: waves his hand from left to right
82         brings you to: (0.8) what region?
83         (1.8)
84         what is after ir?
85         (4.6)
86         it's ↑actually separated into three er near ir (.)
87         mid ir (.) and fa:r ir (0.4) but after fai- far ir
88         what comes in?
89         (2.8)
90         it's a type of radiation that you use at ho:me
```

At the beginning of the extract, Lec initiates a wh- question to elicit a method for determining different functional groups in organic and inorganic compounds. After 1.8 s of wait-time, S1 provides a candidate response with an elongated hesitation marker thereby overlapping with Lec's own correct response to his previous question. In line 7, Lec confirms S1's alternative response that shows S1's more knowledgeable epistemic status (Heritage 2018) about the previously learned academic knowledge, and reformulates S1's response with the addition of his response (inference spectroscopy). From lines 8–12, the lecturer provides extended information about the base numbers of vibration which prepares the ground for his following question. In lines 13 and 14, he formulates another question about a particular spectroscopic method by inserting 'which' into the blank for the correct response, and completes his question with rising intonation (is used for which spectroscopic method?). This different question format signals that the lecturer is attempting to elicit other known information from the students (e.g. Macbeth 2003). From lines 15–18, he initially waits for 1.4 s, and then provides elaboration about 'ir' and 'uv vis', hinting at the correct response as he simultaneously tries to solve a screensharing problem. Following this, Lec reformulates his previous question with the addition of hints and the use of a Y/N format (Koshik 2002) in lines 19 and 20. Despite 2.0 s of silence as a space for a potential short response (line 21), Lec still ***a***nswers his ***o***wn ***q***uestion (i.e. AOQ) with 'yes' as a type-conforming response (Raymond 2003), and then a complete correct response (it is called uv vis spectroscopy).

Between lines 23 and 28, Lec continues to summarize the previously learned information about uv vis and ir spectroscopy. Following this, he initiates another wh- question about an absorption band but deploys AOQ directly rather than eliciting another organic chemistry term to check students' previous learning. After offering a summary of the function of the absorption band to determine band energy (line 31–34), he initiates three wh- questions about the highest occupied and the lowest unoccupied molecular orbital, and the distance between them, in an interconnected way from lines 35 to 39. By utilizing the acronyms (homo and lumo) of the highest and the lowest occupied molecular orbital (line 40), Lec redesigns his question with a wh- question word in the blank where the correct response should be provided and closes the turn with rising intonation (e:r for ↑what (.) property of compou:nds?). Following 3.1 s of silence, Lec uses two alternative chemistry terms (valence and conduction band) instead of homo and lumo, and states that these terms can make more sense (lines 44–46). In line 48, the lecturer reformulates his previous question by using a wh- question (which property is determined by: this separation?). This is followed by 1.7 s of silence, his AOQs, and an understanding check question (oka:y?) from lines 49 to 52.

After providing an explanation of the separation of homo and lumo energy levels (data not shown), the lecturer presages a transition from academic to everyday knowledge by using the vague term 'and stuff' (line 80). This is followed by another quiz-type wh- question, 1.8 s of silence, and a reformulation of his previous question in wh- format. After 4.6 s of silence, Lec provides alternative responses (three types of ir) in a declarative sentence, and initiates a wh- question to select one of these candidate answers, and gives 2.8 s of wait time so that the students can provide a correct response. The foreshadowing of a shift to everyday knowledge is confirmed in line 90, as the lecturer appeals to outside knowledge (Tai and Wei 2020) familiar to all the students in their daily lives (it is a type of radiation that you use at ho:me).

In brief, Extract 1 illustrates how the focal lecturer designs his questioning practices including various formats such as quiz-type wh- questions (e.g. line 14), different chemistry terminology (e.g. line 44), giving wait time (e.g. line 49), and bringing in outside knowledge (line 90). In addition, Extract 1 shows how he answers his own questions (AOQs) when the students show unwillingness to participate (Sert 2013).

Extract 2 shows how the lecturer consolidates this shift by integrating everyday knowledge (heating food with microwave ovens) with the target academic chemistry knowledge through his verbal and embodied actions (e.g. guessing).

Extract 2: microwave

```
91    Lec:  you use ir radiation at home too
92          (1.3)
93          it's e:r (.) with ↑which you're using the
94          ir radiation? [couple things actually
95    S2:                 [microwave
96          (1.4)
97    Lec:  u:r the thing that comes after ir is microwave
98          (.) that's right (0.5) ir you using remote controls
99          you using uh u↑ko:s for heati:ng
100         (1.1)
101         e:r that's ir based instruments that we have at
102         ho:me (0.5) and microwave is (.) what comes after
103         i: r: that region and we use that e:r for heating up
104         ↑foo:d (0.3) right? (0.7) and the ↑reason for that is
105         that this microwave radiation where you ↑ha:ve this
106         (0.5) energy which actually ↑matches with the e:r
107         +rotational+ e:r motions of molecules (0.3) oka:y?
      lec   +----10----+      10: rotates his hands quickly
108         >and a with< e:r the: microwave ↑region that is used
109         in microwave ↑ove:ns (0.3) is actually what matches almost
110         perfectly: (.) with the: rotational spectrum of water
111         (0.8) so u: +(0.4)v:: very ↑fa:stly £start rotating
      lec               +-------------------10---------------->
112         the water molecu:les£+
      lec   ---------------------+
113         and >that that that that< that turns into thermal energy
114         (0.7) right? (0.5) and then it heats up your ↑stuff (0.4)
115         so if there's no >↑water in it< if you try to heat a ↑block
116         of woo:d (0.5) well >block of wood actually ↓has a lot of
117         water in it< but um u:r yeah >i don't know<
118         %e::r +>↑anything that doesn't have any water< then
            %: screenshare stops
      lec         +--------------------3--------------------> line 122
                       3: Lec reshares the screen
119         u::r the heating is actually not (.) not (.) not that
120         efficient it's designed for u::r u:r increasing the
121         rotational motion of u::r water a:nd that's why it
122         ↑heats up and+
      lec   -------------+
```

From lines 91 to 94, the lecturer appeals to outside knowledge and provides hints by stating that the students use ‘ir’ in their houses with ‘couple things’. The last part of Lec's previous utterance is overlapped with S2's response (microwave) (line 95). Thus, Lec manages to elicit a candidate answer from one of the students through shifting to outside knowledge. After 1.4 s of silence, the lecturer confirms S2's answer in a type-conformed format to his previous question in line 84 (what is after ir?), exemplifies these instruments with other instances (lines 98 and 99), and makes a connection between ir and microwave, thus shifting the topic to rotational motion and microwave radiation as a form of electromagnetic radiation. By using verbal and embodied actions (rotating his hands quickly) between lines 101 and 122, Lec explains how rotational motion is conducted in microwave ovens, turns to thermal energy, and heats up food. In sum, Extract 2 demonstrates how Lec manages to elicit a student response (line 95) by bringing in outside knowledge and simplifying his own utterances with more daily language, answering his own question (AOQ), thus interweaving the target academic topic and outside knowledge.

In Extract 3, the lecturer continues to bring in outside knowledge, but this time he links epistemic practices to transportable identities, by holding the students accountable for knowing things because of who they are, and also appeals to different *uses* of the academic knowledge they are building.

Extract 3: cellphone

```
123  Lec:  what is the other u:r thing that you use u:r rotational motion?
124        (0.7)u:r microwave radiation where do we use it? (0.5) other than
125        microwave ovens?
126        (9.8)
127        it's the ↑thing: that you love the most (0.4) your generation
128        (0.8) the thing that you cannot live withou:t (0.5) you have to
129        constantly >look at it<
130        (1.8) all day lo:ng
131        (3.4)
132        what is that?
133        (3.5)
134  S2:   blue screen
135  Le:   you can put
136  S2:   or blue: (.) wa:ve
137  Le:   ↑cell- (.) cellph↓one:s (0.5) ↓cellphones (0.7) oka:y?
138        the ↑cell pho:ne the you know from e:r >you know< from
139        the ↑stations that you just translate information
140        you know e:r that you just ↑call someone that all
141        happens through microwave radiation (0.3) oka:y?
142        .hhh u::r you know why knowing this is important?
143        (4.5)
144        because then you can argue with people that tells you
145        that e:r you know talking on the phone will give you
146        brain cancer
147        (2.1)
148        +↑microwa:ve (0.3) ir (0.7) visible (0.3) u↑v:
     lec   +-------------------11---------------------->
           11: moves his hands from right to left slowly
149        and after uv then you just go into higher+ energy:
     lec   -----------------------------------------+
150        (0.5) ↑light (0.3) you know your ↑x-ra:ys (0.3) your
151        ↑gamma ra:ys (0.7) those are ca:lled ionizing radiation
152        ionizing radiation (0.5) and that that they will kill
153        you (0.5) for sure e:r >you know< some of them will kill
154        you in seconds (.) you you don't even get (.) the chance
155        to get er cancer you will just get radiation poisoning and
156        you'll die in in a week or so: that's what happened to
157        people in u:r in chernobyl
           ((28 lines omitted.)) ((Lec introduces what radiation positioning is with different instances.))
185        so: that that's how you: (.) that's how your cells just
186        becomes out of control and then and then you get cancer
187        .hh but these are (.) this is what happens with ionizatio-
188        (.) er ionizing radiation (.) once you ↑pass uv these ioniz-
189        radiations are n↑o:t ionizing radiation
           ((27 lines omitted.)) ((Lec explains ir energy with another example.))
216        ir is much more energetic than ↑microwave(0.4)so
217        why the hell i don't get any cancer from watching er tv: o:r
218        ↑binge e:- watching a tv series for u:r ↑three days in a row and
219        no- not none of us get cancer right? .hh what the hell happens
220        with the microwave radiation? why people are insisting that
221        >if you ↑talk on the phone< a lot. hh then you will get brain
222        cancer (0.4) that is complete and utter nonsense (0.8) oka:y?
           ((5 lines omitted.)) ((Lec talks about impossibility of getting cancer from cellphones.))
```

In lines 123–125, Lec requests another example of outside knowledge from students in wh- question format including chemistry terms (rotational motion and microwave radiation), but this is met with 9.8 s of silence (line 126). This is followed by Lec leading a kind of guessing game in which he provides different hints (e.g. Laakso and Klippi 1999) from line 127 to 133. While doing this, Lec also positions the students as being more knowledgeable (Heritage 2012) thereby attributing transportable identity (Zimmerman 1998) to students as members of a particular generation. Such positioning using transportable identity can be designed to enable students to become potential providers of preferred responses through physical, cultural, or social relations, and promote their contributions (Waring 2013).

Following the long hint and guess sequence, wh- question, and 3.5 s of silence, S2 offers two alternative answers (blue screen or blue wave) in lines 134 and 136. This is followed by the lecturer uttering 'cellphone' with falling intonation, then two silences of 0.5 and 0.7 s respectively, and an understanding check question. Lec then asks why knowing this information is important and waits for 4.5 s for students to respond in lines 142 and 143. This leads to another AOQ sequence in which Lec suggests that students can use this information to argue with people who claim that cellphones cause brain cancer (lines 144–146). Therefore, the lecturer not only utilizes outside knowledge to elicit responses based on the target academic topic, but he also shows ways in which chemistry knowledge can be useful in their daily lives. Following 2.1 s of silence, Lec shifts from outside knowledge (microwave) to academic terminology (ir, visible, uv), and expands these explanations to revise what ionizing radiation is from lines 149 to 152. He then goes on to give detailed information about radiation poisoning by using the Chernobyl disaster as an example in line 157, adding information about the cancer-causing properties of ionizing radiation from line 185 to 189. Extract 3 closes with Lec restating and emphasizing that it is not possible to get cancer from cellphones or TVs (that is complete and utter nonsense) and his use of an understanding check question (okay?). In brief, Extract 3 displays how Lec appeals to the students' transportable identities to elicit their responses based on outside knowledge (cellphones) through different elicitation practices including guessing sequences while revising previously learned academic knowledge.

Extract 4: daughter

```
228   Lec:  .hhh the only thing that it ↑doe:s i:s it %↑actually heats up
                                                      %:screensharing
                                                        stops
229         (0.6)+it actually heats up the ↑water(0.6) in
      lec        +-------------3-----------------------> line 232
                            3: Lec reshares the screen
230         your brain (0.8) oka:y? (0.5) and the e- brain is (.) is
231         desi:gned (0.8) the brain is desi:gned
232         (3.2)+
      lec   -----+
233         to: >function at a certain temperature<
234         like our entire body is like (.) thirty:: six point
235         five celsius right? .hh >you don't wanna heat< that
236         ↑u:p (.)you don't wanna ↑cook your brain (.)that's
237         right and th- this is e:r this is an experiment that
238         i didn't do: intentionally so i don't experiment on
239         my ↑ki:d but this >turned out< to be: actually an
240         ex↑periment .hh tha:t e:r you know u:r e:r (0.3)
241         ↑my daughter >actually had< a e:r a a e::r a convulsion
242         uh (.) you know ↑high temperature havale geçirdi yani
                                        she went into a convulsion well
243         (.) e:r when she was ↑one year old so we were really
244         obsessed about he:r (0.3) her temperature(0.5) oka:y?
245         we were just constantly feeling her
            (26 lines omitted.)) ((Lec continues to share his experience about his daughter and explains
                                 how people go into a convulsion.))
272         but ↑anyways so we were just really u:r you know
273         +always feeling her (.) always measuring+ her temperature
      lec   +------------------10------------------+
                 10: rotates his hands quickly
274         and what i ↑realized was tha:t (0.3) when she w↑atches tv:
275         (0.8) e:r when she was after two (.) two years o:ld
276         (0.4) when she ↑watches tv for like (.) let's say half an
277         hou:r u:r nothing changes (0.5) however if she watches:
278         u::r from a ↑cell(.) pho::ne then her temperature was
279         (0.3) you kno:w around thirty seven point fi:ve instead of
280         normal thirty six point eight .hh so: her brain
281         temperature was ↑ACTUally increasing (.) the
282         +↑head temperature+ was actually increasing
      lec   +-------12--------+   12: shows his head with both hands
283         .hh because th- (.) because it's microwaves (0.6) oka:y?
284         cell phones are microwaves i mean there's cool videos
285         on youtube you can ↑check they (.) they put actually
286         +u:rm ↑co:rn (0.5) corn bea:ds+ on the table and then
      lec   +----------------13-----------+    13: shows his fingertip
287         they have three cell pho:nes (0.4) ↑looking at (.) the
288         antennas are looking at the: u:r the corn beads and
289         then they call the three cell phones at the same time
290         and they ↑po:p (0.9) you can make popcorn (0.5) with cell pho:nes
291         (1.2)
292         oka:y? .hhh so it's not ionizing radiation (.) it won't give you
293         cancer but it will definitely have a worse effe:cts (.) because
294         it increases the temperature in your brain and when you're
295         olde:r this is not a problem (.) but .hh for small ki:ds
296         (1.7)
297         if you have nephe:ws and or when you have children
298         in the future (.) just have this in ↑mind (0.3).hh
299         the kids (0.6) ha:ve much mo:re higher water content
300         in your brai:n compared to adults (0.4) >okay?<
301         they have ↑much mo:re water in their brain (0.3) so
302         this ↑effect from (.) this ↑heat increase effect
303         from cell pho:ne (0.3) is actually much more prominent
304         .hh and because their brain is developing u:r there's
305         all kinds of development happening the:re (.) you don't
306         wanna mess with the temperature of tha:t (.) that's why
307         we don't allow kids to watch u::r cell phones u::r for
308         for longer perio- long periods of ti:me (0.4) oka:y? but
309         other than tha:t you don't frea:k out (.) none of you're
310         going to get brain cancer (.) oka:y?
311         +(3.8)+
      lec   +-14--+           14: drags up the cursor on the screen
```

From lines 228 to 236, Lec introduces the idea that people can have high temperatures as a result of ir. He presages the story of an unintentional ‘experiment’ he carried out on his daughter, thus orienting to the transportable identity of father rather than the situational one of lecturer in a classroom (lines 237–240). This ‘experiment’ showed that his daughter’s temperature was raised by using a cellphone because of the heating effects of microwaves (lines 240–283). Thus, the lecturer connects his own experience with the academic topic with the apparent purpose of furthering the students’ understanding of the scientific knowledge.

From lines 284 to 290 he adds a further example, in the form of a description of a YouTube video of an experiment in which popcorn was made with three cellphones. Following 1.2 s of silence and an understanding check question at lines 291–92, he restates that these effects are not related to ionizing radiation, and thus will not cause cancer, but microwaves can have the negative effect of causing a high temperature (lines 292–295). The lecturer then ascribes another transportable identity to the students as prospective parents or aunts/uncles of small children, explaining why the high temperature effect of cellphones is more dangerous for small children than adults by incorporating outside (anatomical) knowledge (higher water content in their brains). In lines 309–10, the lecturer restates the idea that cellphones do not cause cancer, asking the students not to ‘freak out’, and he ends his turn with another understanding check (oka:y?) in which the knowledge being checked is somewhat removed from the target chemistry topic. In sum, Extract 4 shows how the lecturer brings diverse outside knowledge (his own experience, a Youtube video), and appeals to both his own and the students’ transportable identities and their associated potentially more knowledgeable epistemic status to drive home understanding about the properties of different types of radiation.

4.2. Autonomy codes analysis

In this section, the different knowledge-building practices elucidated in the Multimodal CA analyses of Extracts 1–4 are re-analysed using the conceptual tools of the Autonomy dimension of LCT. Overall, the trajectory can be described as a rather complex autonomy tour, which starts out in a sovereign code (Extract 1), moves into an introjected code (Extract 2), and then strays into an exotic code with brief excursions into the introjected code (Extracts 3 and 4). For all of Extract 1, the lecturer stays in his sovereign code, as the target is clearly core chemistry concepts, particularly different types of spectroscopy for determining the molecular structure of organic and inorganic compounds. This code is also indicated by the density of chemistry terminology used (*organic/inorganic compounds*, *inference spectroscopy*, *spectroscopic methods*, *absorption band*, *(un) occupied molecular orbital*, *homo* and *lumo levels*, *valence*, and *conduction band*). In terms of RA, the purpose is moving forward students’ understandings of these elements and key relationships between them. As seen in the Multimodal CA analysis, the students appear to be rather unwilling participants, even though the knowledge is positioned as something they have already been introduced to. It seems that being in the sovereign code here is not conducive for student participation, and thus we see the prevalence of the lecturer's practice of AOQs. There is a hint, though, at the end of the Extract that a shift in code is in the offing, where the lecturer at line 90 appeals to outside knowledge (it is a type of radiation that you use at ho:me).

In Extract 2, there is a shift to the introjected code as the lecturer uses non-target elements (remote controls for heating, microwave ovens) to distinguish two different types of radiation (IR and microwave). These are unassociated non-target elements, as remote controls for heating devices or heating food with microwave ovens are not part of the chemistry curriculum and are not educational knowledge in this context. They are elements of everyday knowledge (the 'outside'), brought in for the purpose of illustrating and exemplifying important distinctions in the knowledge being worked on, and thus, in RA terms, they have a purpose intimately related with the lecturer's pedagogical goals. This shift from sovereign to introjected code is depicted in Figure 2.

At the beginning of Extract 3, up to line 137, the lecturer continues in the introjected code as he tries to elicit through the 'guessing game' another everyday example of use of microwaves (cellphones). However, at line 142, there is a shift into a projected code where he highlights a reason for knowing this information that has nothing to do with the purposes of chemistry education (being able to argue with people who think that using your cellphone a lot causes cancer). He goes on to identify the type of radiation (ionizing) that is deadly (either almost instantly or through cancer), and then returns to the idea that it is 'complete and

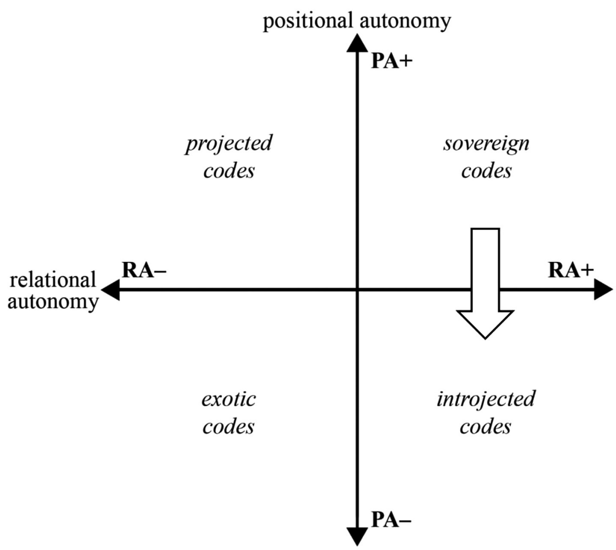

Figure 2: Shift from sovereign to introjected code in Extracts 1 and 2.

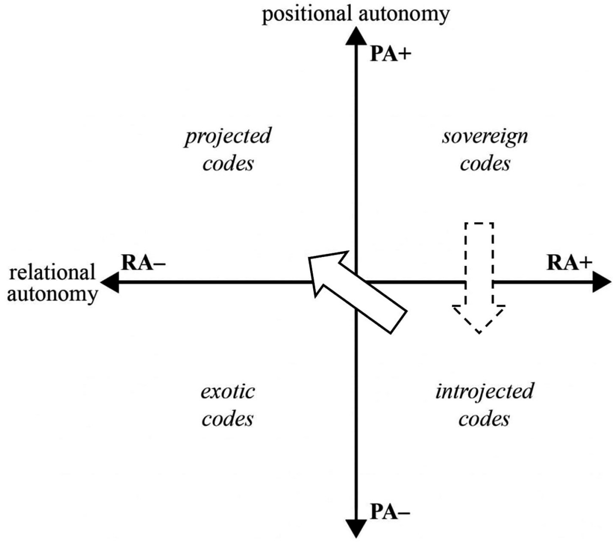

Figure 3: Shift from introjected to projected code in Extract 3.

utter nonsense' (line 222) that using your cellphone can cause cancer. The reason this can be analysed as projected code is that while the knowledge is positioned as a target (types of radiation and their characteristics), it is being used for a purpose other than learning chemistry (debunking a common idea about the negative health effects of a certain type of radiation). These shifts are shown in Figure 3.

In Extract 4, there is a shift into the exotic code, as the elements focused on are unassociated non-target (the brain and its temperature, and the lecturer's daughter's high-temperature episode). In terms of RA, the purpose cannot be clearly identified as the teaching of chemistry, as there seems to be a focus on medical phenomena. However, at line 283, there is a brief foray back into the introjected code, as the lecturer reintroduces the concept of microwaves, and uses the example of making popcorn with cellphones as an example of how microwaves raise temperature. From line 295, however, the lecturer returns to the exotic code, as the non-target content (over-heating of the brain through exposure to microwaves) is dealt with seemingly with the purpose of giving health advice to the students as prospective aunts/uncles or parents, and also to finally drive home the point that microwaves will not give them cancer. These shifts are shown in Figure 4. The upshot of this analysis is that, at the end of this sequence, the lecturer seems to be somewhat stranded in the exotic code. While earlier in the sequence, the brief shift into the projected code has maintained PA in terms of a focus on target knowledge (characteristics of microwaves as a type of radiation), the lengthy excursion into medical matters seems to have lost sight of this, and both in terms of PA (the non-target 'outside' content) and RA (non-target purposes such as giving advice or reassuring about possible dangers to health) the interaction has arrived at a place

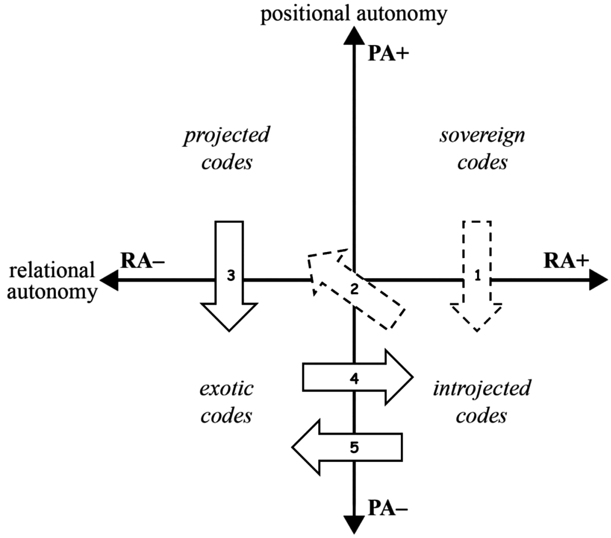

Figure 4: Shifts in code Extract 4.

from where it may be difficult to return smoothly to the sovereign code, although the lecturer does accomplish this (see Extract 5 below).

Overall, then, the trajectory of the whole episode can be seen as a rather complex autonomy tour. Once having abandoned the sovereign code, the lecturer traverses a lot of terrain through the other codes, and, by the end of Extract 4 (around 28 min into the session, about 14 min after the beginning of Extract 1), he still has not got back to where he started. From a pedagogical perspective, this may at least partly be explained by the phenomena identified in the Multimodal CA analysis. In the sovereign code, the lecturer had used a wide range of questioning techniques and generous use of wait-time to attempt to recruit the students as willing participants in the knowledge-building process, especially as he positioned them as knowers in relation to the material. Having failed to recruit them, and having ended up mainly AOQs, he embarked on an autonomy tour which brought in non-target material from the 'outside', positioning students as holders of other types of knowledge attributable to them through their transportable identities. However, this strategy also failed to increase the involvement of the students, although it could be argued that it was, at least initially, effective in bringing together different types of knowledge for the purpose of increasing their understanding of the chemistry. Nevertheless, by the end of the episode it looked as if the lecturer was somewhat adrift, perhaps having lost sight of what he had originally intended to do, and perhaps having lost some of the students along the way.

Interestingly, in the very next line after the end of Extract 4, the lecturer shows awareness of this, in his use of the term 'detour' to describe what had been going on. This can be seen in Extract 5:

Extract 5: detour

```
312   Lec:  so that was a quite a large detou:r e:r bu:t i ↑warned
313         you abou:t this in the first class that i (.) i just
314         wanna tell you some interesting information (.) u:r
315         related to chemistry: u:r and these type of things
316         comes to my mi:nd (.) i- i >you know< i teach this
317         cla:ss differently every time i >you kno:w< whatever
318         pops into my mind u:r that (.) that i find interesting
319         i'll share with you u: (.) .hh  (0.3) e::r ↑bu:t the
320         ↑detour started from +the rotational motion which
      lec                        +--------------10-----------> line 324
                                    10: rotates his hands quickly
321         is related to microwaves bu:t e:r at ↑room temperature
322         when you have >twenty five< degree:s you have enough
323         energy for all these motions (.) the rotations
324         translations+ u::r and vibrations u:r for ↑gases of course
      lec   ------------+
```

In this sequence, the lecturer orients to this type of ‘detour’ as being a normal practice of his. He had already warned the students about his tendency to wander off the topic by telling them about interesting information ‘related to’ chemistry, that happens to ‘pop into’ his mind. Taking these words at face value, they seem to indicate the exotic code, as whatever ‘pops into’ his mind may have only a tenuous link with the chemistry topic being focused on and the purposes of learning chemistry. However, we have seen in the Autonomy analysis that the ‘detour’ spent at least some time in the introjected code, and this would indicate that it had some value from a pedagogical perspective. The sequence ends with a return to the sovereign code (from lines 320 to 324), in a way that contextualizes the ‘detour’ in relation to the chemistry knowledge at play, the relations between rotational motion, microwaves, and temperature. Doing so completes the autonomy tour as he has now returned to the code in which he started out, the sovereign code.

5. DISCUSSION AND CONCLUSION

The analyses presented in this article show how an EMI lecturer brought in knowledge from outside and combined a range of knowledge-building practices simultaneously in order to check, consolidate, and broaden his students’ knowledge of the current chemistry topic and possibly also to encourage student participation. The multimodal CA allowed us to zoom in on the lecturer’s knowledge-building practices at a ‘micro’ level, showing how orientations to different epistemic and identity issues played out in the use of linguistic and other semiotic resources in the smallest details of interaction. The LCT (Autonomy) analysis enabled us to zoom out from these micro details of interaction to focus on the sociological level of knowledge-building practices in which different elements are positioned as either within or without the boundaries of a specific field or sub-field (target or non-target), and in which the uses to which they are put can be seen as furthering the ends of this field or sub-field, or some other purposes. Both levels of analysis, and their combination, have implications for understanding and developing communication practices in EMI contexts, some of which will be briefly discussed here.

The multimodal CA shows in close-up detail how knowledge-building practices are accomplished through the use of linguistic, embodied, and interactional resources. At this level of analysis, knowledge is an emic (participants') matter and is seen through the lens of Conversation Analytic work on epistemics (Heritage 2012) and its extension into classroom discourse studies (Sert 2013). Epistemic practices are also seen in relation to the positioned situational and transportable identities which come into play (Richards 2006). Invoking different types of knowledge (from within or outside the current topic), positioning other participants in relation to this knowledge in terms of epistemic state or status (Heritage 2018) and attributing these states to participants in relation to discourse, situational, and transportable identities (Zimmerman 1998), are all practices which require an extremely artful management of a range of linguistic, embodied, and interactional resources. One element of this interactional practice is that of adapting these resources to different knowledge-building interactional contexts, such as in Extract 1, where the lecturer uses a wide range of grammatical formats in his questioning practices and positions the students as more knowledgeable in terms of the target knowledge. Another important facet of this interactional practice is the management of transitions in and out of the different contexts, both in terms of topic shifts ('academic' to more 'everyday' content and vice versa) and changes in interactional practices (such as shifting from a 'question-and-answer' pattern to announcing and relating an anecdote) in and through interaction.

The LCT autonomy analysis demonstrates that 'bringing the outside in' is a more complex matter than appealing to students' 'funds of knowledge' based on their own experience as members of communities outside the classroom. This is certainly an important part of what is going on, and the lecturer in this study makes at times quite valiant attempts to connect the students' non-academic 'outside' knowledge to the chemistry topic he was teaching. However, the LCT autonomy analysis not only allows us to focus on what 'outside' knowledge is drawn on (and its academic or non-academic nature), but also on how it is used, in terms of the purposes to which it is put. Importantly, it allows us to trace trajectories by which outside knowledge is incorporated in knowledge-building practices and establish a common language for reflection on their effectiveness in pursuing pedagogical goals. In this sense, it expands on the school-based work in studies such as Tai and Wei (2020) to provide a more dynamic picture of how outside knowledge is incorporated into knowledge-building practices.

The results of this study suggest that the lecturer was highly accomplished in terms of the ensembles of linguistic and other resources he used to shift between different epistemic practices and/or autonomy codes in LCT terms. He did not seem to have any trouble in providing examples from outside the confines of the disciplinary topic in English or relating the knowledge under construction to the students' lived experience outside the classroom. However, where he did seem to have some problems was in overcoming the students' apparent unwillingness to participate (e.g. Sert 2015), in spite of positioning them as more knowledgeable as regards the target topic and using a range of question formats. It would be reasonable to assume that his shift to 'outside' knowledge and the beginning of the autonomy tour, were at least in part motivated by the students' unwillingness to participate, although the lecturer himself alludes to 'detours' as being part of his normal practice.

Turning to the implications of the study for the wider field of EMI within applied linguistics, Multimodal CA shows the linguistic and other semiotic resources which are deployed in jointly constructing knowledge in online (and face-to-face) university teaching sessions. LCT allows for the exploration of the organizing principles underlying disciplinary knowledge building practices, thus elucidating the roles of the medium of instruction (English) and other semiotic modes in working with different types of disciplinary and non-disciplinary knowledge for a range of pedagogic purposes. Both approaches can increase understanding of the pedagogical effectiveness of specific knowledge-building practices, and can be adapted to the professional development needs of university lecturers who teach their subjects through the medium of English in non-Anglophone contexts.

SUPPLEMENTARY DATA

Supplementary material is available at *Applied Linguistics* online.

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