"We're talking about mobility:" Discourse strategies for promoting disciplinary knowledge and language in educational contexts

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ARTICLE INFO

ABSTRACT

Content area teachers have a crucial task in promoting students' building of disciplinary knowledge and language. This paper explores, on an elaborated theoretical foundation, how subject-specific knowledge and discourse in educational contexts may be discerned and promoted. The study draws on data from an interdisciplinary design-based three-year research project. Teacher–student interaction in a lower secondary science classroom is examined, and findings from analyzed video-recorded data reveal the complex use of semiotic resources. The teacher seeks to promote student participation and raise awareness about scientific discourse. In this paper, the verbal teacher–student interaction is visualized and described, and the results display a dynamic language use, revealing how the discourse, in wavelike patterns, gradually moves towards dense nominalized expressions, aligned with the features of disciplinary discourse. The results contribute to the understanding of content area teachers' discourse strategies when they seek to facilitate the development of disciplinary knowledge and language.

1. Introduction

Language and literacy are embedded within a range of school subjects, along with their specialized knowledge. Content, language, and other multimodal resources are inseparable aspects in teaching and learning (Schleppegrell, 2016; Unsworth, 2001). Throughout their school years, students encounter increasing focus on specific knowledge and expanding disciplinary language and literacy demands. A school subject can be regarded as a disciplinary discourse, re-contextualized in educational context, with specific ways of reading, writing, speaking, doing, and thinking, which differs from daily perspectives on the world (Halliday & Martin, 1993). These specific conventions within disciplinary practices become even more demanding at the secondary school level. Therefore, it has been argued that explicit knowledge about and attention to language (metalanguage) support students' development of content and expansion of semiotic resources (Rappa & Tang, 2018; Rose & Martin, 2012; Schleppegrell, 2016). Teachers have the crucial task of acknowledging and building upon students' knowledges and resources, promoting the use of various multimodal and multilingual resources, as well as supporting the development of disciplinary literacy (Danielsson, 2016; Gebhard, Chen & Britton, 2014; Hammond & Gibbons, 2005; Haneda, 2014; Jakobson & Axelsson, 2017; Macnaught et al., 2013; Nygård Larsson, 2011). In other words, classroom activities and teaching strategies need to help fill students' "semantic gaps" (Maton, 2013) at the same time as attempting to empower and engage the students (Cummins, 2014).

The focus in the present study is on how the building of and movement towards subject-specific knowledge and disciplinary discourse in educational practice may be discerned and promoted. More specifically, the study explores the educational potential in teacher–student interaction in a Swedish lower secondary science classroom. How does the teacher–student interaction introduce students to scientific discourse and what strategies does the teacher use to promote scientific knowledge and literacy?

To provide a foundation for the findings, the article starts by exploring and outlining some major theoretical approaches to building knowledge and disciplinary language and literacy in educational contexts, including perspectives on how the movement towards disciplinary discourse may be understood and interpreted. The paper suggests that the gradual building of disciplinary knowledge and literacy in classrooms in addition may be conceptualized as recurrent movements between and within discourses.

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2. Knowledge-building and the language of schooling

2.1. A functional view of language

The language in different disciplines constitutes an important research field within the framework of systemic functional linguistics (SFL) (Halliday & Martin, 1993; Halliday & Matthiessen, 2004). SFL scholars make a distinction between language use in everyday common-sense contexts and language use in the specialized practices of schooling, with their various demands in relation to registers and genres for different social purposes. Language proficiency can thus be regarded as register specific. *Register*, according to Martin, concerns linguistic choices in situational contexts and consists of three variables realized through language, which vary according to context (Rose & Martin, 2012). SFL reconceptualizes language as a semiotic threefold resource for meaning-making. The ideational metafunction represents experiences, the interpersonal maintains relational dimensions, and the textual metafunction organizes the flow of information. The register variables realize these potentials in social contexts. Accordingly, language choices and usage vary depending on (1) if the topic, participants, and events within the register variable *field*, are everyday oriented or specialized. It also varies depending on (2) if the communication takes place in close and informal interaction or is more formal and distanced (*tenor*). Finally, it varies depending on (3) the role oral and written language and other modalities play in the textual flow of communication (*mode*).

Written academic text is often abstract, distanced, and technical, typically densely packed with information (Halliday & Martin, 1993). After years of academic study, knowledge has become further specialized and language progressively more technical and abstract, which is related to grammatical changes, where congruent and more "straightforward" expressions are backgrounded due to more nominalized metaphorical ways (e.g., Halliday, 1998) of construing the field. Within SFL and genre-based pedagogy, the aim is therefore to make explicit the requirements placed on students in the expansion of literacy demands (e.g., Christie & Derewianka, 2008; Fang, Schleppegrell & Cox, 2006). Thus, the genre-based literacy approach comprises an explicit focus on metalinguistic awareness and crucial *genres*, or staged realizations of social goals, based on Halliday's SFL, Vygotsky's "zone of proximal development" (ZPD), Bruner's notion of scaffolding, and Bernstein's visible pedagogy (Rose & Martin, 2012).

2.2. Everyday and academic discourses in educational contexts

The differences and relations between informal discourse and the academic and scientific discourses were highlighted in Vygotsky's (1986) distinction between everyday and scientific concepts, and have since been explored and elaborated from an SFL perspective (Section 2.1) as well as from other perspectives. Bernstein (2000) distinguished between horizontal (everyday) and vertical (academic) discourse and further conceptualized different kinds of academic knowledge as hierarchical and horizontal knowledge structures. However, it is important to emphasize that the educational level constitutes a pedagogic discourse that re-contextualizes vertical discourses. Maton (e.g., 2014) developed a four-fielded model, *the semantic plane*, based on legitimation code theory (LCT) derived from Bernstein's sociological framework on codes and knowledge structures. The plane is a field of *semantic codes*, with the variables *semantic gravity* (context-dependence of meaning) and *semantic density* (complexity of meaning). This concept has been further conceptualized within the interdisciplinary educational research project (DISKS) (Martin, 2013; Maton, 2013; Macnaught et al., 2013) and explored in relation to the register variables of SFL (Martin, 2017; Martin & Matruglio, 2013).

According to Maton (2014), the concept of semantic codes avoids dichotomous division in everyday and academic knowledge. The variation and strength of semantic gravity and semantic density generate semantic codes within social fields of knowledge practices (Martin & Maton, 2017). The transformation of knowledge can be viewed as movement between these variables along a continuum of strength. Stronger semantic gravity indicates a more context-dependent, specific, and concrete meaning, while weaker semantic gravity implies less context-dependent, general, and abstract meaning. Stronger semantic density implies a complex condensation of meaning, and weaker density stands for the opposite. Semantic codes are situated in knowledge practices and can be used for analysing pedagogic discourse (see also Maton & Doran, 2017, for linguistic "translation devices"). According to Maton (2014), the four-fielded model of the semantic plane (Fig. 1) should not be interpreted as separate boxes. Rather, the strengths vary around the plane. This means that activities and discourses within practices move between and within these spaces. Thus, all practices involve various strengths of semantic gravity and semantic density (SG+/−, SD+/−).
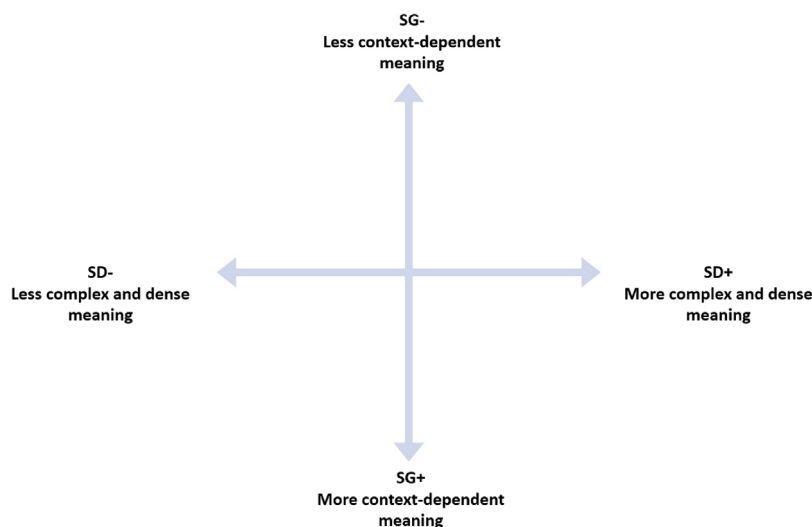

Fig. 1. The semantic plane, or the field of semantic codes, adapted from Maton (2014). *Semantic gravity* (SG−/+) is the degree to which meaning relates to its context. *Semantic density* (SD−/+) is the degree of complexity and condensation of meaning.

Less contextual support

Less cognitive demands and challenge   More cognitive demands and challenge
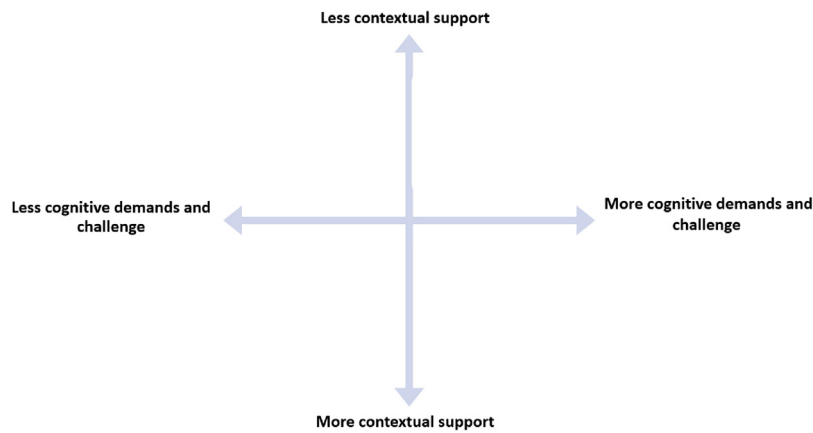
More contextual support

Fig. 2. The teaching and learning plane. A second-language perspective on the degree of contextual support and cognitive complexity in classroom activities (adapted from Cummins, 1981; Gibbons, 2009; Mariani, 1997). In the present paper, the axes are turned: "contextual support" is normally placed on the horizontal line (higher degree to the left), and "cognitive demands and challenge" on the vertical line (higher degree on the top).

From a second-language perspective, Cummins (1979, 2000) explored the language challenges related to school success and developed the distinction between BICS and CALP (basic interpersonal communicative skills; cognitive academic language proficiency), or everyday language and academic language skills. Cummins (1981) developed these concepts further into a more dynamic educational four-fielded model, which combined the degrees of *cognitive demand* and *contextual support*. Cummins's model has been related to a four-fielded model of teaching zones (Mariani, 1997), comprising the degrees of *challenge* and *support*, which others, including Gibbons (2009), developed further. These models are illustrated in combination in Fig. 2. However, the model is partly reversed in the present paper, with turned axes, in order to be more adapted and comparable to the axes in Maton's model (Fig. 1).

Accordingly, classroom tasks with high degrees of both challenge and support are, for many students, likely to offer an effective scaffolding developmental zone (the lower-right zone, Fig. 2), containing rich contextual support such as practical assignments, group work, interactional negotiation, visual aids, and acknowledgement of students' background knowledge and first languages. In this zone, students have the opportunity to manage cognitively demanding tasks and, with the right support, head towards student autonomy (Gibbons, 2009; Mariani, 1997). Typically, the lower-left zone is dominated by ordinary daily interactions and experiences, while the upper-right zone comprises more demanding academic tasks such as writing essays. The upper-left zone, in turn, consists of tasks that students can perform relatively easily, without processing.

The LCT model (Fig. 1) comprises a sociological epistemic-semantic perspective, while the second-language model (Fig. 2) is oriented towards language usage and classroom instruction. However, both are used as educational models and add perspectives to the exploration of knowledge-building and the language of schooling. The emphasis in the LCT model is strong regarding the fact that activities and discourses within practices "move around the plane" and vary in strength. However, this is also underpinning the second-language model, although it stresses the development factor. The following sections will further explore the complexity and variety of knowledge-building in educational contexts.

2.3. Semantic waves and scaffolding

According to Maton (2013, 2014), weakening semantic gravity involves moving from the specific and concrete towards more context-independent, general, and abstract meaning.
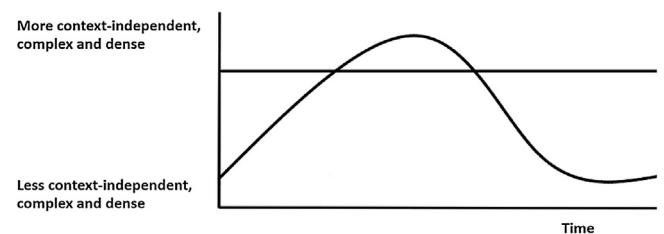
More context-independent, complex and dense

Less context-independent, complex and dense

Time

Fig. 3. Two simple semantic profiles on a time-line: a high semantic flat-line (the straight line at the top) and a "semantic wave" (the curvy line), adapted from Maton (2013) and Macnaught et al. (2013).

Strengthening semantic density means a movement towards more complex and condensed constellations of meanings. The DISKS project uses the notion of *semantic waves* (Martin, 2013; Maton, 2013) to describe and illustrate the recurrent movements in pedagogic discourse. In these analyses, the semantic codes are combined in *semantic profiles*, which trace changes over time within practices, such as the unfolding of classroom practice. In other words, the semantic profile comprises and displays the continuous strengths of both context dependency and complexity. When illustrating semantic profiles, the variables of semantic gravity and semantic density are combined in two poles (SG+/SD− and SG−/SD+) (Maton, 2013). For the sake of simplicity, the DISKS project used a scale in which semantic gravity and semantic density move inversely, thus not involving other possible combinations of the poles (SG+/SD+, SG−/SD−). On a time-scale, semantic waves occur when there is a variation in strength and a wider semantic range between the poles. Low or high flat-lines, in turn, occur when there are limited shifts in discourse, and therefore do not display this waving pattern on the time-scale (Fig. 3).

Maton (2013) and Macnaught et al. (2013) point out that teachers often unpack dense written discourse into more context-dependent spoken discourse. However, teachers more seldom repack, or model upward shifts and create waves by returning to more condensed and complex meanings. The question is, how can classroom activities mediate written discourse and avoid this "semantic gap" (Maton, 2013)? Teachers and students need to both *unpack* and *repack* the negotiated meaning, and "teaching to wave" can therefore serve as a discourse strategy for student empowerment (Martin, 2013; Maton, 2014).

Semantic profiles can be analyzed on macro-level, between practices, and on micro-level, within (part of) practices (Maton, 2014). Thus, *waves within waves* can be conceptualized as "micro-waving," in phases of lessons, and "macro-waving," across lessons.

This may be compared to Hammond and Gibbons' (2005) notion of teachers' scaffolding on macro- and micro-levels, with the aim of "supporting-up" and extending discourse, rather than "dumbing-down" and simplifying the curriculum, in relation to Mariani's (1997) conceptualization of scaffolding as a combination of high challenge and high support. According to Hammond and Gibbons (2005), macro-scaffolding, or "designed-in" scaffolding, comprises planned task sequencing that involves metalinguistic awareness, background knowledge, and choices of tasks and participant structures (pair, group, whole-class). Micro-scaffolding, or "contingent" scaffolding, in turn, includes moment-to-moment interactional scaffolding, such as linking to prior experience and pointing forward, summing up and recapping, appropriating students' contributions, then recasting and expanding into more disciplinary discourse by extending the third move in the three-part IRF-exchange *Initiation, Response, Feedback*. Moreover, Gibbons (2006) conceptualizes oral discourse as a bridge to writing. That is, building of academic knowledge and language is supported by a bridging movement along a mode continuum (the SFL register variable mode), from oral small-group talk and hands-on activities, via extended whole-class talk, to formal written communication.

2.4. Semantic waves from a functional linguistic and multimodal perspective

Within the DISKS project, Martin (2013) outlines how the building of the register variable *field* through *technicality* ("power words") strengthens semantic density. A technical term is often part of a complex web of meanings. Scientific taxonomies are considerably deeper than everyday ones and re-contextualized in pedagogic discourse (Halliday & Martin, 1993). Learning technical terms involves expanding these meaning networks, through unpacking and repacking. That is, they need to be elaborated in classroom interaction and specified in relation to the patterns of *activity sequences* and *taxonomies* (Martin, 2013). According to Martin, fields are systems of activity sequences (e.g., implication sequences, temporal sequences). They involve processes as well as taxonomies, organized by *classification* (kinds of; type and/or subtype) and *composition* (parts of; part and/or whole). These field-aspects, activity and taxonomy, organize the knowledge in interplay and lead further to new definitions and extended descriptions and explanations in written and multimodal texts, thus related to the notion of *genre* and genre-based pedagogy (Martin, 2013; Rose & Martin, 2012; Unsworth, 2001). In relation to semantic waves, these two field-aspects constitute movements between *definition and classification* (upward shifts towards condensed meaning) and phases of *description and explanation* (downward shifts towards specified and elaborated meaning).

From the perspective of SFL, *grammatical metaphor* (e.g., Halliday, 1998) is crucial for knowledge-building, and technicality and semantic density depends on this "power grammar" (Martin, 2013). Furthermore, it allows a movement towards abstraction, which affects semantic gravity. The conventional congruent way of expressing meaning is the representation of processes in verbal groups and the representation of entities in nominal groups. *Experiential metaphor* realizes the meaning in incongruent ways, such as representation of processes in nominal groups. Therefore, nominalized technical terms, such as "inflammation," involve both entity and action, thereby posing a double, or metaphorical, meaning (notably, not all *nominalizations* have this double, or metaphorical, meaning). Furthermore, some nominal groups contain complex activity sequences, for instance "cell division." Processes can also be realized through adjectives ("living species"), which may be called *adjectivization*. This experiential metaphor is similarly densifying and may facilitate scientific description (Nygård Larsson, 2011).

However, these "hidden" metaphorical meanings can be partly unpacked and repacked in the classroom.

In addition, a range of semiotic resources is intertwined with knowledge-building and contribute to the multimodal construction of school subjects (e.g., Unsworth, 2001). Nygård Larsson (2011) uses the notion of *discourse mobility* or *discursive mobility* to describe the multimodal two-way movement between and within different discourses and their inherent, specific ways of thinking and acting. This mobility involves movements between common sense and un-common sense meaning, as well as concrete, abstract, specific, and general meaning. A high level of discursive mobility may imply that teachers consciously move between different expressions to maximize learning opportunities. Similarly, students need to develop their discursive mobility, in step with the expansion of the literacy demands. Everyday linguistic and multimodal expressions may constitute a resource. However, the potential for teaching and learning lies in the mobility between and within discourses and modalities. Consequently, there are several connections to the concept of semantic waves (Martin, 2013; Maton, 2013).

Examples of this discursive mobility from an ethnographic study (Nygård Larsson, 2011), are the upper secondary biology teacher's acknowledgement of both verbiage and image in the textbook. Naturalistic (everyday) and abstract technical images (Kress & van Leeuwen, 2006) are explicitly interpreted and interrelated in classroom interaction, providing the students various representations of the object. This leads to movements that comprise concrete and abstract, as well as specific and general objects, such as items, colour photographs, and analytical drawings displaying classification or composition. Furthermore, activity sequences and taxonomies (Martin, 2013) are often visualized through written board notes in interplay with these images. Moreover, the teacher's oral interaction is not simplified but extended, rewording students' responses and unpacking and repacking movements comprising congruent and incongruent grammatical realization (Halliday, 1998). The implicit taxonomic relations in the textbook are in addition explicitly acknowledged in the teacher's recurrent visualizations of taxonomic relations in the classroom, creating semiotic coherence in time and space, on both macro- and micro-levels. Finally, the teacher models and discusses explicitly how the construing of abstract and general images, derived from more concrete and specific images, can serve as tools in scientific knowledge-building and thinking. In other words, there is a meta-discussion about multimodal scientific discourse, although not so much about metalinguistic aspects of this discourse.

3. The study

The focus in this study is on the building of and movement towards more subject-specific knowledge and disciplinary discourse in educational context. More specifically, how does teacher–student interaction in a science classroom introduce students to scientific discourse? What strategies does the teacher use to promote scientific knowledge and literacy?

The analyses draw on data from the interdisciplinary research project, Science and Literacy Teaching. The aim of the three-year project is to explore and enhance the development of knowledge, language, and literacy in science teaching and learning, by observing natural settings and the enactment of design-based collaboration (Deen, Hajer & Koole, 2008; McKenney & Reeves, 2013). The full data set comprises classroom data from two Swedish lower secondary schools, including surveys and interviews, and data from a subsequent professional development literacy programme at one of the schools. The data collection period was 1.5 years. The study

was conducted by following ethical guidelines as stated by the Swedish Research Council (2017).

The data in the present paper were taken from an initial substudy in one school, with a science teacher and a grade 7 class with students aged 13–14. The science teacher had limited training in language-related issues. However, he shared the attempt of the school to develop strategies for a language approach on teaching. In grade 7, about 40% have a first language other than Swedish. The grade 7 class in this paper consists of 27 students, and 37% report that they have a first language other than Swedish. Six students were born abroad, whereas three of them arrived before schooling.

The data from this class consist of classroom observations, video and audio recordings, students' assignments, photos, and four video-recorded interviews with the teacher. The teacher and the class participated in the project for nearly 2 months. The classroom data comprises five weeks of observation, consisting of six one-hour video-recorded lessons. This period was followed by one week of interventional collaboration. The design of the lessons during this week was realized and flexibly enacted by the teacher, based on proposals from and discussions with members of the research project (Maaike Hajer, Anders Jakobsson, Pia Nygård Larsson, Clas Olander). In the present paper, this enactment in classroom setting is analyzed and the focus is the whole-class interaction. The video-recorded classroom data from this week consist of four lessons, about 3.5 h in total, resulting in 10 h of recording. Three cameras recorded from different angles and have all been used in analysis and transcription, to achieve greater accuracy.

In the excerpts (Section 4), the teachers' talk is marked T and the students' talk is marked S. To some extent, adaptation is made to written language conventions. Exact pronunciation and precise measurements of the pauses are excluded in the Swedish transcript and the English translation. Punctuation marks (full stop, question mark) are used. In addition, commas are used in the English translation for better readability. Omitted parts of transcript are marked with /.../. Context information is added within brackets [writes]. Extra-bold type in the excerpts marks analytical findings. In excerpts 2–5, the Swedish transcript (italic type) is placed below the English version.

3.1. The instructional phases of the designed lessons

Many students in the class showed a low degree of participation in classroom work, and according to interviews with the teacher, there were difficulties in engaging the students, except for a couple of higher-performing students. Therefore, as a starting point, the mutual aim for the teacher and the project group was to promote student participation and engagement and raise awareness about scientific discourse. Hence, in the introduction of a new working area within biology ("What is life?"), the teacher consciously attempts to engage students in the field and make them aware of the discourse by making connections between students' wordings and more scientific discourse, at the same time alternating between participation structures (small-group, whole-class), during three macro-phases. Below follows an overview and description of the instructional phases of the designed lessons.

(1) The first lesson starts with an *explorative group-work*, with four students in each group. At first, the students individually consider four objects in front of them on the table (stone, worm, potted plant, potato). They must decide, and write down, on a shared four-fielded paper in the middle of the table, which one of the items should be excluded and why. Then, they are supposed to read and discuss the answers, and arrive at a mutual decision, which they are instructed to write down in the centre of the paper. This work, drawing on students' background knowledge, is followed by a *whole-class interaction* in which the choices are discussed. Here, the teacher's aim is also to make connections between students' wordings and more scientific discourse. Thus, this phase follows the pattern "Individually–group–whole class."

(2) In a second *explorative group work*, each group receives an envelope with 18 pictures of organisms (colour photography), and they are instructed to discuss and decide suitable categorizing. Each group glues the pictures on a plate, accompanied by some writing and drawing (labelling, short description, arrows). This work is followed by a *whole-class interaction* in which the groups report their findings, under the guidance of the teacher. The plates are then displayed on the classroom wall.

(3) In a third *group work*, the students immerse themselves (in expert groups) in one animal species each. They read in the textbook and search on Internet, and they write down their results according to specific writing instruction. This work should later be reported in inter-groups. However, this macro-phase is only partially realized due to external circumstances. Instead, the group-work is concluded by a short *whole-class interaction* in which two aspects concerning the species are highlighted by the teacher.

Unfortunately, after a short school holiday, the teacher does not return to the school for the remaining school term, and by that our collaboration with the teacher and his class is interrupted. Still, the analyses reveal significant findings in relation to the theoretical underpinning outlined in Section 2.

3.2. Analytical approach

On a macro-level, the instructional phases (Section 3.1) seem to promote a gradual movement towards more disciplinary knowledge and language. In relation to *the teaching and learning plane* (Section 2.2, Fig. 2), the phases seem to be mainly, but not entirely, situated in the lower right zone and slowly moving upwards and to the right within this zone. This gradual movement is combined

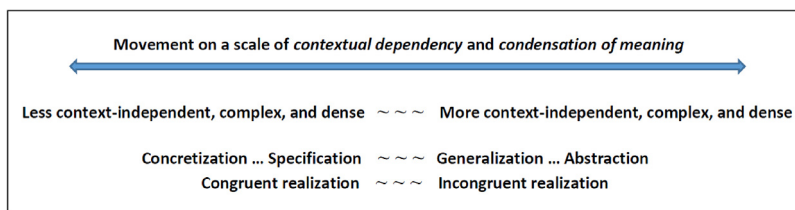**Fig. 4.** Photos from the first and second macro-phase.

Fig. 5. The scale of contextual dependency and condensation of meaning, adapted for the analyses of teacher–student interaction in this study.

with recurrent movements between explorative student-active exercises and teacher-led, subject-specific elaboration, which comprise multimodal group-work involving items, pictures, drawing, talking, and writing, and more language-oriented whole-class interaction (Fig. 4).

The focus of the case study in this paper is the whole-class interactions during these phases, and the findings will present the micro-waving pattern within these interactions. In line with the theorizations in Section 2, the analyses draw on the notions of contextual dependency, condensation of meaning, semantic waves, and discursive mobility (e.g., Martin, 2013; Maton, 2014; Nygård Larsson, 2011). The notion of semantic waves can be used in analyses at various levels, including both qualitative and quantitative comparative approaches (Macnaught et al., 2013; Maton, 2014). The concept is used in the present study for the close examination of language use in classroom discourse. However, Maton's (2014) model (Section 2.3, Fig. 3) is reversed, illustrating classroom interaction on a horizontal scale, ranging from left to right, instead of vertically. These movements constitute a continuous scale with no exact limits. Fig. 5 displays the operationalization of the model.

Within a research project on language use in science education, a similar reversed model was used to trace changes in students' oral group interaction regarding movements between everyday and scientific discourse (Nygård Larsson & Jakobsson, 2017). However, the model in the present paper is further elaborated in terms of how it describes the aspects of the scale. Furthermore, the present study especially focuses on the movement between congruent and incongruent realization of meaning (e.g., Halliday, 1998), although other aspects in Fig. 5 are also present. Incongruent realization is conceptualized as a more nominalized discourse comprising nominalizations and adjectivizations forming various dense expressions with an underlying "double" meaning, which may occur as grammatical metaphors in texts. Grammatical metaphor realizes the meaning in incongruent ways; for example, representation of processes in nominal groups (nominalization, such as "rapid growth"), or representation of processes through adjectives (adjectivization, such as "living species"). A more conventional and congruent way of expressing meaning is the representation of processes in verbal groups (for example, "they live, and they grow fast"). As Martin (2013) points out, grammatical metaphor strengthens semantic density, as it is crucial for knowledge-building and technicality. It also affects semantic gravity, as it allows a movement towards abstraction (Section 2.4).

Thus, the model in Fig. 5 is used as an analytical tool that serves as a mean to examine and interpret the varied language usage displayed in classroom discourse. Thereby, the focus is not mainly the interactional exchanges per se, but rather the linguistic movements in the discourse. Furthermore, the model provides visualization of the discourse (e.g., Section 4.1, Excerpt 2), which may facilitate the understanding of the dynamic language use in educational contexts.

4. Findings

The gradual building of knowledge and language in educational contexts may in addition be conceptualized as a simultaneously and constant movement between and within discourses or as a waving pattern of various strengths regarding contextual dependency and condensation of meaning (Martin, 2013; Maton, 2013; Nygård Larsson, 2011). The findings focus analyses of teacher–student whole-class interaction during the three macro-phases (see Section 3), revealing a waving pattern of congruent and incongruent discourse (Halliday, 1998).

4.1. Phase 1

The first lesson started with an explorative group-work (Section 3.1), which gave the students time to think, discuss, and write down their conclusions. Then, in the whole-class interaction, the teacher initially stated that he wanted to hear the students' arguments about which object should be excluded and why. The students suggested the stone (Excerpt 1).

Excerpt 1. Teacher–student interaction. Teacher (T). Students (S), numbered according to first appearance. Extra-bold type in the excerpts marks analytical findings. Swedish transcript is to the right.

1	*T:* Then, I'd like to hear the arguments you all have. What have you chosen and why? … Yes?	*T:* Då skulle jag vilja höra vilka argument ni har. Vad har ni valt ut och varför? … Ja?
2	*S1:* We have written that the stone should be removed because it's the only one that doesn't **need soil to live.**	*S1:* Vi har skrivit att stenen ska bort för att det är den enda som inte **behöver jord för att kunna leva.**
3	*T:* [Writes to the left on the board "need soil"] … It needs soil to live. Did you say that?	*T:* [Skriver till vänster på tavlan "behöver jord"] … Den behöver jord för att leva. Sa du så?
4	*S1:* The stone doesn't need soil to live. The others need soil to live.	*S1:* Stenen behöver inte jord för att leva. De andra behöver jord för att leva.
5	*T:* Okay. Need soil [completes the notes "need soil to live"] … Can you write it in any other way?	*T:* Okej. Behöver jord [på tavlan "behöver jord för att leva"] … Kan man skriva det på nåt annat sätt?
6	*S1:* It **needs soil to grow.**	*S1:* Den **behöver jord för att växa.**
7	*T:* Needs soil to grow [writes to the left "to grow"] … Okay. Did anyone else choose that the stone should be removed … Yes?	*T:* Behöver jord för att växa [skriver till vänster "för att växa"] … Okej. Nån mer som valt att just stenen ska bort? … Ja?
8	*S2:* It should be removed because it's **not organic… It's hard.**	*S2:* Den ska bort för den är **inte organisk… Den är hård.**
9	*T:* What do you mean by not organic? [writes to the right "not organic"]	*T:* Vad menar du med inte organisk? [skriver till höger "inte organisk"]
10	*S2:* It **doesn't consist of organic substances** and it's **not alive.**	*S2:* Den **består inte av organiska ämnen** och den är **inte levande.**
11	*T:* Not alive [writes to the left "not alive"]	*T:* Inte levande [skriver till vänster "inte levande"]
12	*S2:* The stone is **found on other celestial bodies** in the universe. The others aren't found on celestial bodies that we've discovered. And … it **doesn't need water.**	*S2:* Stenen **finns på andra himlakroppar** i universum. De andra finns inte på himlakroppar som vi upptäckt. Och … den **behöver inte vatten.**
13	*T:* [Writes to the left "is found on other celestial bodies"] … Actually, then you mean that the others need water [writes to the left "need water"]	*T:* [Skriver till vänster "finns på andra himlakroppar"] … Egentligen menar ni att de andra behöver vatten då [skriver till vänster "behöver vatten"]

Most of the students' arguments during whole-class interaction are connected to an everyday discourse (e.g., turn 2 and 6, Excerpt 1), in line with the answers on the student tablets during group-work. This will also be evident in the following excerpts. There is one exception, however. S2 (Excerpt 1) uses the term "organic" and the common-sense argument "it's hard" (8). When the teacher asks him to clarify (9), he easily extends his statement and moves between various arguments (10, 12): "It doesn't consist of organic substances," "it's not alive," "the stone is found on other celestial bodies," "it doesn't need water."

Initially, the teacher's feedback on students' suggestions consists mainly of repetition, orally and in writing (e.g., Excerpt 1, turn 3, 5). However, the teacher rapidly seeks to expand the students' wordings into more disciplinary discourse. Excerpt 2 displays the students' arguments about the removal of the worm. The teacher attempts to transform these suggestions into more subject-specific wordings, and he seeks to write everyday wording to the left on the board, and more subject-specific wording to the right. He explicitly tells the students that the aim is to find these expressions (7), and he occasionally discusses specific word choices (9, "Should we rewrite it like that?"). Moreover, the teacher's disciplinary wording is partly incongruent and abstract, which becomes visible in both speech and writing. Excerpt 2 visualizes this movement, on a scale from left to right (see Fig. 5, Section 3.2).

Excerpt 2. Visualization of the teacher–student interaction. English translation is followed by Swedish transcript (in italics). Extra-bold type in the excerpts marks analytical findings.

Movement on a scale of *contextual dependency* and *condensation of meaning*
Congruent realization   ~ ~ ~   Incongruent realization

1 *T:* Can anyone find arguments for why
   the worm should be removed?
2 *S4:* It's the only one that **is an animal.**
3 *T:* Okay. The worm could be removed
   because **it's an animal** [writes to the left
   on the board "is animal"] ... Exactly.
4 *T:* [S5]
5 *S5:* It's the only one that **moves on its own.**
6   *T:* It has ... **the ability to move ... Movement...**
            I'll just write that over here [writes to the right "movement,"
                              in Swedish "rörelse"]

7 *T:* Okay. Does anyone have something else to
   take up? /.../ No. Okay. Let's see if you can find
   some links between what we're saying and
   how a biologist might express himself. Actually,
   I had intended to use a different colour here.
8 *S3:* [Teacher's name] I can change the worm.
   Shall I say it? The worm should be removed
   because it's the only one that **can move.** Wait.
   It's the only one that **can move with muscles.**
9   *T:* **Muscles ... Movement.**
                With muscles ... [writes to the
         right "movement-muscles"] ... So, **transportation.**
                    Movement creates ... **Mobility,**
         one might say then. Should we rewrite it like that?
10 *S3:* Yes
11   *T:* [changes to "Mobility;"
                in Swedish "rörelseförmåga"]

   [puts brackets around "muscles"] You also said **muscles** ...

1 *T:* Nån som kan hitta argument för att masken ska bort?
2 *S4:* Det är bara den som är ett djur.
3 *T:* Okej. Masken skulle kunna gå bort för att
   den är djur [skriver "är djur" till vänster] ... Precis.
4 *T:* [S5]
5 *S5:* Det är bara den som rör sig självmant.
6   *T:* Den har... förmågan att röra sig... Rörelse...
            skriver jag här borta helt enkelt [skriver "rörelse" till höger]
7 *T:* Okej. Är det nån som vill få fram nåt annat? /.../ Nej.
   Okej. Ska vi se om ni kan hitta lite kopplingar till hur
   vi säger nu och till hur kanske en biolog uttrycker sig också.
   Jag hade egentligen försökt tänka på annan färg här.
8 *S3:* [Lärarens namn] Jag kan ändra masken. Ska jag säga det?
   Masken ska bort för det är den enda som kan röra sig. Vänta.
   Det är den enda som kan röra på sig med muskler.
9   *T:* Muskler... Rörelse. Med muskler ...
            [skriver till höger "rörelse-muskler"] ... Så förflyttning.
                    Rörelse skapar... Rörelseförmåga
         kanske man ska säga då. Ska vi skriva om det på det viset?
10 *S3:* Ja
11   *T:* [Ändrar till "rörelseförmåga"]

   [sätter parentes runt "muskler"] Muskler sa du också ....

In Excerpt 2, three students gradually expand the arguments for the worm to be excluded: "It's the only one that is an animal (2), "It's the only one that moves on its own" (5), "It's the only one that can move with muscles" (8). The teacher then expands, both orally and in writing, by suggesting several more incongruent, abstract and dense expressions (6, 9, 11): "ability to move," "movement," "transportation," "mobility" (in Swedish "förmåga att röra sig," "rörelse," "förflyttning," "rörelseförmåga"). Student S3 seems to seek a more specific argument with the proposal "can move with muscles" (8). This in turn seems to cause the teacher to find a more appropriate wording, and he then decides to rewrite by using the word "mobility." Thus, the excerpt displays two distinct waves, peaking at the words *movement* and *mobility*. However, the Swedish word "rörelseförmåga" (mobility) is in English rather "movement-ability." That is, the nominalization that the teacher writes on the board is a dense compound word, gradually derived from the previous incongruent wordings, which in turn builds upon the congruent wordings of the students.

Thereafter (Excerpt 3), the teacher explicitly states that the conversation is about "mobility" (the Swedish word "rörlighet"). Further, he focuses mobility as a general process and expands by asking an additional question, related to mobility of the specific plant and potato: "Aren't these mobile?" (1). A student responds, "I think they grow, but they don't move" (2). The teacher suggests, in his feedback, the congruent expansion "They grow and get bigger" (3), which he immediately transforms into the nominalization "growth" (5) and explicitly suggests as a general criterion. Consequently, the academic noun "growth" ("tillväxt") is now used, derived from the verb "grow" ("växer"), and by that another wave is created, via the student's suggestion.

Excerpt 3. Visualization of the teacher–student interaction. English translation and Swedish transcript.

	Movement on a scale of *contextual dependency* and *condensation of meaning*
	Congruent realization ~ ~ ~ Incongruent realization
1	**T:** We're talking about **mobility.** Aren't these **mobile?** The plant and the potato?
2	*S7:* I think they **grow,** but they **don't move.**
3	*T:* They **grow** and **get bigger.**
4	*S7:* [inaudible]
5	*T:* **Growth** could be a criterion here, in general. Is that what you're thinking too? [writes to the right "growth," in Swedish "tillväxt"]
1	*T: Vi är inne på det här med* **rörlighet.** *Är de inte* **rörliga** *här? Växten och potatisen?*
2	*S7: Jag tror att de* **växer** *men de* **rör sig inte.**
3	*T: De* **växer** *och* **blir större.**
4	*S7: [ohörbart]*
5	*T: Tillväxt skulle kunna vara ett kriterium här då generellt. Är det så du tänker också? [skriver till höger "tillväxt"]*

Thus, in these exchanges, the teacher models how actions are turned into entities, which can be used as criteria and further discussed. That is, the movement towards a disciplinary discourse is realized through incongruent expressions. Excerpt 4 displays an additional example of this movement towards abstraction and subject-specific wordings. The teacher initiates by asking for other possible selections except for the need for soil.

Excerpt 4. Visualization of the teacher–student interaction (S2 also participates in Excerpt 1).

```
        Movement on a scale of contextual dependency and condensation of meaning
             Congruent realization      ~ ~ ~      Incongruent realization
    |<--------------------------------------------------------------------------->|

1   T: These three here need soil. Does it apply to all life
                    then, that they need soil? Is there another selection?
2   S1: Someone needs water. Water movements
    and such. They don't need soil.
    They need water to breathe.
3   T: Breathe. There you're on to something
      [writes to the left "need water, breathe"]
    ... Need water. Need to breathe...
    What's it called? In biology?
    Those who need water? Need to breathe.
      Or we breathe. Actually, they use gills, so it's not really breathing.
        Is there a good word for that, in biology?
4                                                      S2: Oxygen intake.
5                                                      T: Oxygen intake.
          Yes, exactly. It's oxygen
          that they need, regardless.
    [A student comes in, short interruption]
6                T: Okay... So, we were talking about the need for oxygen intake.
          As I have been doing this for a while, I might also call it respiration
                                    [writes to the right "respiration"]
                          ... But oxygen intake
          is good, I think. It summarizes exactly what respiration is.

1   T: De här tre behöver jord. Gäller det för allt liv
                    egentligen då att de behöver jord? Finns det ett annat urval?
2   S1: Nån behöver vatten. Vattenrörelser
    och sånt. De behöver inte jord.
    De behöver ju vatten för att kunna andas.
3   T: Andas. Där var du inne på nånting
    [skriver till vänster "behöver vatten, andas"] ...
    Behöver vatten. Behöver kunna andas...
    Vad heter det? I biologin?
    De som behöver vatten? Behöver andas.
      Eller vi andas. Egentligen använder de gälar så det är inte riktigt andning.
        Finns det nåt bra ord för det i biologin?
4                                                      S2: Syreintag.
5                                                      T: Syreintag.
          Ja precis. Det är syre
          oavsett de behöver.
    [en elev kommer in, litet avbrott]
6                T: Okej... Då var vi inne på att det behövs syreintag.
          Jag som hållit på med det kan kanske kalla det respiration
                          också [skriver till höger "respiration"]
                          ... Men syreintag
          tycker jag är bra. Det sammanfattar precis vad respiration är.
```

S1 responds to the teacher's initiation by suggesting "They need water to breathe" (2). The teacher appropriates this suggestion, both orally and in writing, and in an extended third move, he repeats the congruent wordings "need water" and "need to breathe" several times. He then expands by concluding that the specific use of gills means that it is not really a question of the process of breathing. He also asks for a more subject-specific wording (3). S2 suggests "oxygen intake" (the Swedish compound word "syreintag") (4). Consequently, another and more general nominalization for the process is suggested. This causes the teacher to repeat the term and move the discourse to the left, by expanding and clarifying with the congruent "it's oxygen that they need" (5). He then extends by moving to the right again, with the incongruent "need for oxygen intake" (6). Finally, he concludes by adding the even more disciplinary term "respiration" (6). Hence, in the interaction, connections are established between these various wordings and the waving pattern peaks at the words *oxygen intake* and *respiration*.

As a written product, the following notes are visualized on the board (Fig. 6). To the right, the notes consist merely of academic or subject-specific wordings and nominalizations.

What started as a relatively contextual dependent and explorative group-work, now models academic language features. This includes a multimodal movement from artefacts to abstract oral and written wordings. In other words, contextual independency and condensation of meaning strengthens, as the content is "packed" in the interaction (Martin, 2013; Maton, 2013). However, the incongruent wordings are not explicitly highlighted, per se.

4.2. Phase 2

Excerpt 5 is from the whole-class interaction following upon the second explorative group-work based on students' background knowledge (categorization of organisms, see Section 3.1). As in previous excerpts, it shows a similar movement between congruent (2, 6) and incongruent (3, 7) expressions, and a quite intense waving pattern. Here, adjectivizations are used for construing descriptive characteristics, out of the congruent wordings of the students.

Why? Argue with your own words!	A biologist says	Varför? Argumentera med egna ord!	En biolog säger
Not alive **Found on other celestial bodies** **Need soil to live** **Is an animal**	**Not organic** **Mobility** **(muscles)**	Inte levande Finns på andra himlakroppar Behöver jord för att leva Är djur	Inte organisk Rörelseförmåga (muskler)
Need … to grow **Need water, breathe**	**Growth** **Oxygen Intake, Respiration**	Behöver…för att växa Behöver vatten, andas	Tillväxt Syreintag, Respiration

Fig. 6. Copy from the board. English translation and Swedish original. "Celestial bodies" to the left may seem surprising. However, in Swedish, the word "himlakropp" may be slightly more associated with everyday discourse.

Excerpt 5. Visualization of the teacher–student interaction. English translation and Swedish transcript.

	Movement on a scale of *contextual dependency* and *condensation of meaning*
	Congruent realization ~~~ Incongruent realization
1	*T*: What… **division** did you make? … Your group? What **selection** have you made?
2	*S10*: We **divided** animals into animals that **live on land** and animals that **live in water**.
3	*T*: "Water living" and "land living" [aquatic and terrestrial, in Swedish "vattenlevande" and "landlevande," which he writes on the right of the board]
4	*S11*: Smart!
5	*T*: Many have made this **division** … And you have plants and animals separated as well. One could also gather plants and animals that are "**land living**". Okay?
6	*S1*: Things you **can eat**.
7	*T*: If they're **edible** or **inedible** [points at the board] Do you have the same **division** here?
8	*S1*: Yes.
9	*S3*: So … does that mean that they **live in water**? [points at the word "water living"]
10	*T*: "Water living" … Then they **live in water**.
11	*S11*: If they're "**land living**", like bats and birds. They **fly** around in the air… But do they count as "**land living?**"
12	*T*: Yes, that's a good question. They **land** sometimes. And then they also have quite a lot of time up in the air. These could be **divided** into flying and "**land living**" … **live in the air**, simply put, and **on the ground**… Any more **divisions** that you have chosen?
1	*T: Vad har ni gjort för… indelning? …Eran grupp? Vilket urval har ni gjort?*
2	*S10: Vi har delat upp djur i djur som lever på land och djur som lever på vatten.*
3	*T: Vattenlevande och landlevande [skriver till höger]*
4	*S11: Smart!*
5	*T: Många har gjort den indelningen … Och så har ni tänkt växter och djur också för sig. Man skulle också kunna samla växter och djur för sig som är landlevande. Okej?*
6	*S1: Saker som man kan äta.*
7	*T: Om de är ätliga eller oätliga [pekar på tavlan] Har ni samma indelning här?*
8	*S1: Ja.*
9	*S3: Alltså… gälls det där som att de lever i vatten? [pekar på ordet vattenlevande]*
10	*T: Vattenlevande … Då lever de i vatten.*
11	*S11: Om de är landlevande. Alltså fladdermöss och fågel. De flyger ju runt i luften…. Fast räknas de som landlevande?*
12	*T: Ja det är en bra fråga. De kanske landar ibland. Alltså och så har de också ganska mycket tid uppe i luften. De här skulle kunna delas upp i flygande och landlevande … lever i luften helt enkelt och på marken … Mer indelningar som ni har valt?*

This interaction also reveals two interesting questions posed by the students (9, 11). S3 asks for clarification about whether "water living" is the same thing as "they live in water" (9), which is confirmed by the teacher (10). This question suggests that the use of more incongruent wording poses a challenge for some students. However, S11 freely uses both congruent and incongruent wordings, to reflect upon the criteria for categorization (11, "They fly around in the air… But do they count as 'land living'?"). Here, the teacher's feedback also reveals his positive confirmation of the students' explorative reasoning about classification (12, "…These could be divided into flying and 'land living'…").

At the beginning of phase 2, the teacher explicitly highlighted *classification* as a disciplinary activity. In a linguistically extended instruction, he referred to the first group-work while introducing the second, and by that moving between several congruent
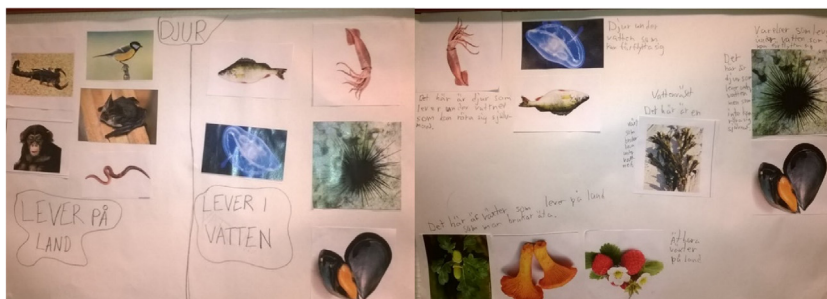
Fig. 7. Two examples of students' categorization of organisms.

Verb	Adjectivization	Nominalization
		(often compound words)
move		movement
(rör sig)		(rörelse)
can move on its own	mobile	mobility
(kan röra sig självmant)	(rörlig)	(rörlighet)
		ability to move
		(förmåga att röra sig)
		"movement ability"
		(rörelseförmåga)
can transport itself		transportation
(kan förflytta sig)		(förflyttning)
grow... and get bigger		growth
(växer... och blir större)		(tillväxt)
breathe		breathing
(andas)		(andning)
need oxygen		need for oxygen intake
(behöver syre)		(behov av syreintag)
		respiration
		(respiration)
live on land	"land living"	
(lever på land)	(landlevande)	
live in water	"water living"	
(lever i vatten)	(vattenlevande)	
fly	flying	
(flyger)	(flygande)	
can eat	edible	
(kan äta)	(ätlig)	
cannot eat	inedible	
(kan inte äta)	(oätlig)	
divide		division
(dela in/upp)		(indelning, uppdelning)
select		selection
(välja ut)		(urval)
sort, group... classify		classification
(sortera, gruppera... klassificera)		(klassificering)

Fig. 8. Teacher–student interaction – a summary on a word-level.

and incongruent exemplifying wordings referring to classification (extra-bold type below). Consequently, by using several nominalizations and dynamic verbs (material processes, Halliday & Matthiessen, 2004), he moves between the general scientific process and the active work of the students:

Then you're talking about **division**. Do you agree that we have made a **division**? You've **selected criteria** for what should be excluded, didn't you? Actually, that's the way a biologist works... It's often about **classification**. To **divide**/.../You'll now get some pictures, and you'll **sort** them, like a biologist does. How do you **group** them? . . . And I want you to **find arguments** for how you did it...

(Då är ni inne på **uppdelning.** Är ni med på att vi gjort en **uppdelning**? Ni har själva **valt ut kriterier** för vad som ska bort eller hur? Det är faktiskt så som en biolog arbetar. . . Det handlar

mycket om **klassificering.** Att **dela upp**/. . ./Ni ska nu få några bilder och ni ska **sortera** upp dem så som en biolog gör. Hur **grupperar** man dem?... Och jag vill att ni **hittar argument** för hur ni har gjort. . .) (Excerpt 6, English translation and Swedish transcript)

At the end of phase 2, the teacher tells the students to hang their plates on the wall. Fig. 7 provides an overview of two examples of student categorization. The multimodal plates display categories such as "live on land," "water living," "animals that can move," "edible." These are now visualized on the wall, and the classifications may later be extended. Furthermore, the plates jointly display both congruent and incongruent wordings, although not equally spread over the plates.

In addition, the whole-class interaction in phase 2 serves another function. When the students report on their findings, the teacher encourages them to try to name the species orally, by that

How does it get its **nutrition**? (What does it **eat**?)	Hur får den sin **näring**? (Vad **äter** den?)
How does it **reproduce**? Lifecycle? (How does it **get children**?)	Hur **fortplantar** den sig? **Livscykel**? (Hur får den **barn**?)
Habitat? (Where does it **live**?)	**Habitat**? (Var **lever** den?)
Defense? (How does it **protect itself**?)	**Försvar**? (Hur **skyddar** den **sig**?)
How does it **transport itself**? (How does it **move**?)	Hur **förflyttar** den **sig**? (Hur **rör** den **sig**?)

Fig. 9. The writing instructions. English translation and Swedish original (bold type is analytical marking).

supporting the students to identify and label the specific species, such as "sea urchin." That is, the classifying movement comprises both specific and general categories. When concluding phase 2, the teacher introduces the biology textbook and the chapter of organisms (systematics), which they will use in the next phase. He also contextualizes and confirms the students' work so far:

> This is how you've been working today. You found your own selection, as a biologist does. [quoting the book:] "The forest has its organisms, and the sea has its own. A life in the air requires a completely different body than a quiet life on the bottom of the sea." And you've also thought about air, bottom of the sea, land. You're thinking like a biologist. (Excerpt 7)

4.3. A summary on a word-level

Fig. 8 summarizes, on a word-level, the congruent and incongruent realizations in the interactional exchanges in previous excerpts. Besides incongruent realizations, a frequently used linguistic feature in Swedish is compound words. Thus, nominalization and adjectivization often occur within compound words (e.g. "rörelse-förmåga" or "movement-ability").

The words to the left (Fig. 8) are mostly expressed by the students and the words to the right by the teacher (adjectivization and nominalization). Both teacher and students are also shunting between the words to some extent. Thus, these language features are modelled in classroom discourse although not explicitly acknowledged as a grammatical resource for meaning-making.

4.4. Phase 3

In the third group-work (see Section 3.1), the students immerse themselves in one animal species each, by reading the textbook and searching on Internet. They write down their findings according to the teacher's specific writing instructions. In these instructions, the movement between various expressions also becomes visible (Fig. 9). The teacher has placed the everyday "translations" in congruent format within brackets. The more subject-specific wordings alter between congruent and incongruent realization.

Furthermore, the students receive a writing frame, similar to the instructions. Thereby, they are at this stage not expected to produce lengthy, structured information reports but rather to find and write down descriptions under each caption. Thus, the frame is intended to support the students' writing (students' texts not analyzed in this paper). However, the students mostly explore the disciplinary discourse in the textbook on their own, although in collaborative group-work. This writing frame models to some extent the text type (classification and description, combined with temporal sequences, Martin, 2013). However, the teacher does not explicitly refer to this.

Phase 3 is not completed by the end of the week (Section 3.1). However, to get some closure of this week's work, the teacher ends with a short comparison of two aspects: "nutrition" and "reproduction." He writes on the board "eats–nutrition," "get children–reproduction." Then, he asks the students to give examples according to their species. Hence, these two abstract and general aspects are highlighted and related to the more specific content that each group has been exploring, thus displaying a similar waving pattern as in other analyses in this paper.

5. Conclusion and implications

This paper has highlighted how the movement towards disciplinary knowledge and discourse in educational contexts may be discerned and promoted. The gradual building of knowledge and language in these contexts may in addition be conceptualized as a waving pattern or as a recurrent movement between and within discourses (e.g., Martin, 2013; Maton, 2013; Nygård Larsson, 2011). This is suggested in the theorizations described in this paper and may be summarized by the variables *contextual dependency* and *condensation of meaning* as well as further conceptualized by the metaphors *semantic waves* and *teaching to wave* (Macnaught et al., 2013; Martin, 2013; Maton, 2013). The findings in this paper exemplify the discourse strategies of a science teacher and contribute to a deeper understanding of content area teachers' discourse strategies when seeking to promote students' development of knowledge, language and literacy and attempting to bridge the "semantic gaps" (Maton, 2013) between and within discourses.

Research (e.g., Hammond & Gibbons, 2005) suggests the benefits of careful consideration on the choices of participant structures and the use of teacher-led talk. The findings in this paper display a recurrent interplay between multimodal explorative group-work and language-oriented whole-class interaction. In this paper, the teacher–student interaction is visualized and described, and the results display a dynamic use of semiotic resources and reveal how the discourse, in wave-like patterns, gradually moves towards dense expressions and between levels of concretization, specification, generalization, and abstraction. Grammatical metaphor is a linguistic meaning-making resource and crucial in literacy development (Halliday, 1998; Halliday & Martin, 1993). The findings display a movement between congruent and incongruent realization of meaning and the visualizations of the whole-class interaction reveal a micro-waving pattern. Consequently, there is a potential for interactional scaffolding, when it comes to modelling these discourse features and promoting disciplinary discourse. The teacher uses the third move in the interactional exchanges to model, extend and expand the discourse (Hammond & Gibbons, 2005). However, even more importantly, the teacher foremost asks open explorative questions and creates a space where the students' answers are appreciated and built upon.

Not all students are orally active in the whole-class interaction. However, relatively many students are. Science is often considered alienating for students (e.g., Lemke, 1990; Olander, 2013). When it comes to students' participation and engagement, the teacher's contextualized and explorative student-active approach, as well as the affirmation of the students as co-constructers of knowledge, may promote student empowerment and a stronger academic literacy engagement (Cummins, 2014). The teacher seeks to construct the students as knowledgeable and actively involved in the explorative building of knowledge and language. Thus, he attempts to construct the students as scientists, providing a space for curiosity, where the students are encouraged to make proposals and legitimate claims of knowledge. Furthermore, according to the teacher's own reflexion in an interview, he felt that he was able to engage many students by this approach.

In other words, an analysis of the data suggests that the teacher and the students appear to jointly approach disciplinary ways of doing and thinking as well as expressing the knowledge. Students' everyday wordings are acknowledged as explorative

meaning-making resources, allowing them to expand their knowledge and semiotic resources. This approach goes beyond a focus on experimental lab-work or linguistic features, per se. Instead, it invites the students into an exploration of scientific discourse in a broader sense.

The attempt of the teacher in the present study is only emergent, and the findings suggest several ways for developing a more conscious approach. The teacher focuses on subject-specific wording and models the movements between everyday and subject-specific discourse. However, an explicit meta-knowledge about features such as nominalizations may support both the teacher and the students in the interpretation and production of dense written discourse (Fang et al., 2006; Gebhard et al., 2014). The recurrent movements between levels of concretization, specification, generalization, and abstraction may also be acknowledged.

The analytical model used in this paper, although not detailed or precise in every aspect, appears to contribute relatively effectively to the interpretation and explicit visualization of the dynamic language usage. It therefore also has potential to contribute to teaching practice. That is, the visualization of teacher–student interaction may deepen teachers' understanding of disciplinary discourse.

Furthermore, the teacher highlights explicitly the field-aspect *taxonomy* (Martin, 2013) by focusing classification as a disciplinary activity in the whole-class interaction. This may be more consciously aligned with the written discourse of the textbook, which in turn may allow for the technicality of the field to be further explored, thereby strengthening the condensation of meaning. One of the main genres in school science is the "information report" (Martin, 2013). To pay attention to this classifying and describing text type would be in line with the content. Thus, the classifying activities and the writing frame used by the teacher may serve as explicit models for further interpretations of taxonomies and activity sequences and more extended student writing. Additionally, an explicit multimodal approach gives opportunities to detect the taxonomic relations suggested in textbook (Nygård Larsson, 2011).

Moreover, further developments would be to acknowledge student's multilingual resources as well as critical literacy perspectives (García & Wei, 2014; Gebhard et al., 2014; Haneda, 2014; O'Hallaron, Palincsar & Schleppegrell, 2015).

These approaches involve professional development of content area teachers which is an essential concern in many countries. The findings from this study, in line with other studies, illustrate the importance of such a development (e.g., Hajer & Norén, 2017; Macnaught et al., 2013; Rappa & Tang, 2018). Knowledge and semiotic resources are intertwined, and the building of disciplinary discourse and literacy rely heavily upon content area teachers and their ability to effectively support the students' in expanding their semiotic resources while exploring complex meaning relations and moving between levels of concretization, specification, generalization, and abstraction.

Conflicts of interest

None.

Acknowledgements

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