

# Teachers' Way of Contextualizing the Science Content in Lesson Introductions

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## ABSTRACT

Previous studies have pointed to the benefits of involving students' everyday life experiences in lessons and in contextualizing the science content to enhance learning and positive attitudes toward school science. However, most of these investigations have been conducted as intervention studies. By contrast, the present study explored how teachers, in authentic situations and without interventions, related the school science context to other contexts. We analyzed a total of 490 min of lesson introductions in Swedish Grade 9 classes. The results revealed that teachers employed contextualization at the intersection of science content and the everyday life context, the school context, and the language context. Furthermore, it appeared that contextualization was created in the moment, as a way of explicating the scientific content. Compared to intervention studies, the present study shows that occasions of contextualization are rare. It is possible to conclude that the use of contextualization in science learning situations could be viewed as a teacher competence and must be explicit in teacher education and professional development to achieve the benefits of enhanced student interest and learning shown in the mentioned intervention studies.

**KEY WORDS:** contextualization; science teaching; authentic situations; lessons

## INTRODUCTION

For the last few decades, a major challenge in Western countries has been enhancing young people's interest in science and technology. As far back as 1975, Ormerod and Duckworth (1975) concluded that the "swing from science" had begun; it was grounded in a declining interest in the science subjects. In 2014, Potvin and Hasni concluded in a review that the problem of students' lack of interest in science persists. They also noted that the interest in science and technology decreases as school years progress and identified a large gap between school science offerings and students' preferences. Other studies have reached similar conclusions, stating that school science is not communicated in a personally relevant way and does not allow for discussion (Osborne and Collins, 2001; Barmby et al., 2008; Christadou, 2011). Several large-scale studies (OECD, 2013) have identified a lack of interest and negative attitudes toward learning science. This is also true for students in countries that achieve high results on international large-scale science tests such as Program for International Student Assessment and Trends in International Mathematics and Science Study. Therefore, while students may achieve high results on these kinds of tests, they may also find school science generally irrelevant or uninteresting (Hofstein et al., 2011). However, several studies have shown that the issue of interest is actually more complex, as students express negative attitudes toward school science and are positive about popular science in a practical context (Häussler and Hoffman,

2000) and about science related to societal issues and everyday life (Cerini et al., 2003). To incorporate more context-based teaching, many scholars have advocated the inclusion of socioscientific issues (SSIs) in science instruction (Zeidler et al., 2005; Ratcliffe and Grace, 2003), wherein teaching also includes everyday problems that can be described as complex, often interdisciplinary, and including social aspects, scientific knowledge, and sometimes conflicting values. According to Zeidler et al. (2009), the SSI framework may comprise discrepant scientific, social, or moral viewpoints, which may be in conflict with students' own beliefs.

Holbrook and Rannikmae (2010) argued that introducing science in a familiar context provides possibilities to enhance students' interest in and intrinsic motivation for learning science. Consequently, teachers must also consider contexts other than that of school science as a resource for science learning. Many studies have focused on implementing different teaching methods and strategies in the science classroom, and thereafter evaluating aspects such as students' learning outcomes or students' experienced engagements (Crawford, 2000; Wierdsman et al., 2016). However, not many teachers and science classrooms have the possibility to take advantage of the collaborative work between teachers and researchers that comes through setting up intervention studies. Therefore, we are interested in increasing our understanding of how teachers use contextualization in teaching situations without interventions. Few studies have explored teachers' in-action

approaches to scientific content, contextualization and how it is communicated in the classroom. Consequently, what happens in the science classroom in terms of how contextualization is outlined without intervention has been seldom scrutinized and discussed. This is valuable knowledge in terms of, for example, how to approach and plan future professional development and available learning resources at governmental platforms to reach broader groups of teachers.

The present study explored how teachers employ and relate other contexts to that of school science to facilitate negotiation of the presented scientific content. We aimed to identify how contextualization was outlined and framed without interventions in authentic situations. Contextualization is understood here as the use of additional contexts in relation to school science to explicate and negotiate the discussed scientific content.

## BACKGROUND

### Framing Science Education through Contextualization

As argued above, the socioscientific approach to science instruction has been promoted as a way of enhancing students' interest and motivation for learning science. One fundamental idea for using SSIs involves putting science content, scientific explanations, and theories into a wider context, thereby enhancing the relevance of science education to students (Zeidler et al., 2005; Ratcliffe and Grace, 2003). According to Wierdsma et al. (2016), a context is defined as a representation of a social practice constructed for educational purposes. Several studies have highlighted that involving a broader context in science lessons increases students' engagement and interest and may contribute to making science personally relevant for the students. For example, Feierabend and Eilks (2010) explored students' perceived relevance of a teaching sequence involving authentic and controversial issues. The students responded positively to the cooperative learning methods, the relevance of the topics, and how the presented dilemmas corresponded to their personal interests. In a recent study by Schmidt et al. (2019), students reported that science lessons generally had low relevance to them. However, when teachers employed frequent relevance statements, students also tended to report higher personal relevance of science lessons. One way of exploring how students engage meaningfully in scientific practices was suggested in a framework of epistemologies in practice provided by Berland et al. (2016), in which students' epistemic ideas are a combination of ideas and actions. The authors argued that it is impossible to assume that practices that enable progress toward the goals of the scientific community are experienced as meaningful to learners. The authors referred to meaningful activities such as those focused on students' perceptions regarding reasons for completing a specific activity.

As a way of theorizing the approach of implementing various contexts, Holbrook and Rannikmae (2010) suggested adopting a teaching cycle of contextualization; that is, contextualization,

de-contextualization, and re-contextualization. They argued that initiating science teaching in a contextual frame that students are familiar with could enhance the students' interest in and intrinsic motivation to learn science. Their approach suggested introducing science topics by including social contexts that involve science, to highlight relevance and create a need to learn more science. The de-contextualized mode focuses on structuring scientific knowledge and learning scientific skills, while re-contextualization comprises drawing conclusions on the contextual frame based on new scientific knowledge. Similarly, Feierabend and Eilks (2010) suggested a model for instruction that emphasizes movement among different teaching contexts. This model involves problem analysis from an everyday context, clarification of the scientific content, refocusing on the socioscientific dilemma, negotiation in role-playing tasks, and a meta-reflective activity involving the underlying scientific issues. These kinds of concrete teaching models offer support for more actively and explicitly moving between the scientific and everyday context in teaching situations. Wierdsma et al. (2016) suggested another method of re-contextualization, wherein instruction in an upper-secondary science classroom focused on a storyline with embedded crucial concepts, as well as episodes contextualizing concepts in societal practices. Their results suggested that the strategy of re-contextualization is a fruitful way of enhancing students' learning behavior and of distinguishing among a preparation phase, a re-contextualizing phase, a reflection-on-re-contextualizing phase, and a test phase.

Another way to consider this movement between contexts is to acknowledge the issue of hybridity. Early studies of hybridity often captured the translation struggle of differences in language use and in contexts on borderlands (Arteaga, 1994; Valle and Torres, 1995). Such translations can occur, for example, in learning situations wherein people try to make sense of new notions in relation to their previous conceptual and contextual understanding. Wallace (2004) argued that hybridity theory emphasizes how people in any given community draw upon multiple resources to make sense of the world, and that being "in-between" different funds of knowledge or discourses may be both constraining and productive in both social and cultural settings such as a science classroom. According to Wallace (2004), hybridity can be related to third spaces, which are hybrid spaces in which various contexts and funds of knowledge are brought together.

### Science Learning and Language Learning

Lemke (2000) emphasized that science teaching and learning is a linguistic activity, given that an important feature of learning science is to learn the language of it. Lemke continued by linking learning the language of science to the fact that science and science education is a human social activity that occurs within institutional and cultural frameworks. In so doing, Lemke emphasized not only social interactions between humans but also the cultural setting in which science education takes place. According to Gutiérrez et al. (1999), learning contexts are immanently hybrid, which means that

they are polycontextual, multivoiced, and multiscripted; this, in turn, means that learning spaces entail conflicts, tensions, and diversity. However, rather than viewing hybridity as problematic, the authors argued that it provides important cultural resources for students' knowledge development.

Kamberelis and Wehunt (2012) used the notion of hybrid discourse practice as a way of describing how students import knowledge and discursive strategies from popular culture and media to accomplish complex school tasks and assignments. Students create a heterogeneous form of discourse that involves different forms of talk, social interaction, and material practices (using artefacts) from various social and cultural contexts, thereby generating interactional and communicative spaces. According to the authors, hybrid discourse practices involve the interplay of at least three key elements: Lamination of multiple cultural frames, shifting relations between people and their discourse, and shifting power relations among people. From empirical data, the authors found that hybrid discourse practices help students engage in and understand science content and connect their out-of-school knowledge and personal interests to the subject being taught. Furthermore, Nygård Larsson and Jakobsson (2019) concluded that students who can use hybrid discourses and move between everyday and scientific languages benefit from this exchange, while students who only use colloquial language or relate the content to everyday experiences become disadvantaged in learning situations.

The above is in line with the discussion of Krajcik and Sutherland (2010). They reviewed approaches for developing student literacy in science and their point of departure was that literacy is defined as the understanding of science content and scientific practices and the ability to use that knowledge to participate in decision-making processes, and also the ability to critique the quality of evidence about science (National Research Council, 1986). Krajcik and Sutherland (2010) suggested five curricular features: Linking new ideas to prior knowledge and experiences, anchoring learning in questions that are meaningful in the lives of students, connecting multiple representations, providing opportunities for students to use science ideas, and supporting students' engagement with the discourse of science.

### Teaching Strategies and Contextualization

According to the above discussion, learning settings can be considered as hybrid spaces (Wallace, 2004) or as movements between different teaching contexts (Feierabend and Eilks, 2010), but how do teachers acknowledge and deal with this movement during instruction? Several studies have investigated teaching approaches and how teachers consider their own strategies of teaching in the science classroom. For example, Hashweh (1996) asked teachers to describe their own strategies for teaching science and found that they mainly referred to three categories of teaching. The first strategy emphasized scientific concepts through the teachers' own explanations. The second strategy involved different forms

of representations, such as demonstrations, student activities, and analogies, to convince the students of a correct scientific explanation for a phenomenon. The third strategy was to confront students with alternative, non-scientific conceptions.

Karthigeyan (2014) investigated student teachers' ideas regarding how they design their teaching. The results indicated that the student teachers mainly emphasized interactivity, lectures, and visualization. Karthigeyan argued that the student teachers tended to disregard their pupils' prior knowledge and experiences when framing various cognitive activities. Based on the above examples of studies, the issue of contextualization or movement between different contexts does not seem to be an important part of the involved teachers' strategies. Yet, most studies dealing with teaching strategies appear to have focused on various kinds of interventions in relation to teaching strategies or teachers' epistemological beliefs (Wierdsma et al., 2016). A common approach has been to explore interventions through inquiry-based instruction. For example, Crawford (2000) examined the beliefs and practices of secondary teachers who developed inquiry-based science instruction and how student-teacher interactions developed. The results suggested a need for a collaborative inquiry model for teaching and learning, where the development of conceptual understanding is a shared learning experience. Williams and Clement (2015) also explored various kinds of discussion-based strategies in science instruction. They identified both macro- and micro-level strategies for enhancing students' science learning. It seems that some interventions may have a greater impact on students' achievements than others. According to a meta-analysis by Schroeder et al. (2007), interventions focusing on enhanced context strategies have the highest impact on students' achievement in science. The interventions in this category consist of teachers referring to students' prior experiences or engaging students' interest when considering the school's environment or setting. Interventions that had less impact on students' achievements were collaborative learning strategies, followed by questioning strategies, and finally inquiry strategies. The results of the meta-analysis comprised studies that aimed to intervene in ongoing teaching and learning practices; thus, the question remains how uninfluenced science teaching considers the possibility of creating enhanced contexts.

## METHODOLOGICAL CONSIDERATIONS

Many previous studies have argued that science instruction should be contextualized and made personally relevant to students. Therefore, our interest in the present study was in exploring how teachers employ school science and relate it to other societal contexts. One possible approach is to explore how SSI is employed in science classrooms. The use of SSI in teaching situations explicitly involves working with dilemmas or societal problems, which focuses on argumentation and providing different points of view in relation to scientific facts (Zeidler, 2014). By contrast, the present study aims to investigate how teachers use contextualization to emphasize

and make relevance of the scientific content. In this way, contextualization provides an opportunity to use various resources to explicate a specific phenomenon, serving as a bridge between the school science context and other familiar contexts. As argued in the previous section, most studies that focus on context strategies or different ways to approach the scientific content in school are intervention studies, in which researchers actively affect the science teaching situations and evaluate the impacts. The present study asks how contextualization is constituted in real, authentic classroom situations. Therefore, we explored the nature of contextualization without any interventions in authentic situations. Our research question was:

- In what ways is contextualization constituted in authentic situations by science teachers when introducing science lessons?

This study was a part of a larger project that had the overarching goal of exploring teachers' and students' use of multiple contexts and use of language in Swedish science classrooms. To approach this goal, six different schools were chosen to represent city schools, urban schools, and small-town schools. In all, 195 students and their 14 science teachers participated in the study. The data collection consisted of video observations from all science lessons (15-year-old students) during a teaching period of 2–3 weeks. Participation was voluntary and an informed consent was signed. It was possible to withdraw this at any time during the data collection. While the topics taught varied, all were related to the curriculum for compulsory school and to the learning goals of the syllabus. In all, the data comprised approximately 200 h of video.

For this study, we concentrated on the lesson introductions as an approach for analyzing the data from the perspective of exploring teachers' ways of contextualizing the science content. This meant that the analytic focus was on the teachers and did not involve students' reactions or responses to teachers' efforts to contextualize the science content. We assumed that the start of a lesson would be an occasion that was expected to relate the scientific content to other, perhaps more familiar contexts and, in that way, negotiate the scientific content. While it is most likely that teachers employed various contexts in situations other than during lesson introductions, this was not our focus. In this study, a lesson introduction refers to the occasion on which the teacher starts the lesson and ends when a new activity begins. Examples of this activity could include collaborative work, a student experiment or students working on their own. On some occasions, the teacher continued holding a lecture, which made it difficult to identify the end of the lesson introduction. Even though these cases could not only be considered as introductions, we used the same definition for ending our analysis; that is, when a new activity replaced the introduction. Five lesson introductions lasted for more than 20 min. On average, the introductions lasted for 11 min.

We analyzed all lesson introductions in all whole-class situations. A total of 44 introductions, totaling 490 min, were

analyzed, with the focus on identifying situations where teachers not only refer to the science but also use other resources or contexts to make relevance of lesson topics. The topics taught could presumably impact on the extent to which the teachers employed multiple contexts. However, the quantity of the data material may compensate for the fact that some specific topics could be more difficult to contextualize in some lessons.

The data analysis was thematic (Braun and Clarke, 2008) and consisted of three phases. The first overall approach aimed to reveal situations in which the teachers related school science to other contexts for explicating the presented scientific content. This meant that the analysis included identifying all attempts from the teachers to highlight links to another context. This phase could be considered as deductive or theoretically driven, with the focus of research decided in advance. A total of 75 situations were identified as containing both scientific and additional contexts. Several lesson introductions contained more than one situation of contextualization, while others identified no additional contexts other than the school science. The second phase of the analysis involved suggesting different thematic patterns into which the different contexts could be categorized. Thus, this analytic phase was inductive and data-driven because there was no pre-existing classification. Furthermore, the aim here was a semantic approach, which departs from description and evolves into an interpretation of the patterns' significance and their implications (Braun and Clarke, 2008). This phase was conducted independently by two different coders. In the third phase of the analysis, the different categories were negotiated, confirmed, and finally summarized into three main categories. This included the authors reviewing the themes and defining and classifying instances to the three different main categories of everyday life context, the school context, and the language context. While the authors agreed on the categorization for most situations, a few were renegotiated and finally decided upon as belonging to one of the three categories.

The first category is broad and, as the name implies, involves a wide range of situations that could emerge in everyday life. As seen in the results description, the situations comprise (a) relating scientific phenomena to everyday occurrences, (b) references to movies/media, or (c) short stories related to popular science. Segments (a)–(c) were considered as subcategories to the everyday life context. The second category involved a broad school context where references to other school subjects constituted the main part. Finally, the language context concerns different linguistic references, such as (a) relating words to other languages or (b) relating scientific words to everyday words; these were considered as subcategories to the language context.

## RESULTS

From the data material, we found 75 situations in which the teachers involved contexts other than only school science, thus creating possibilities for contextualization. These situations are

described here as contextualization occurring at the intersection between school science context and three different areas: The everyday life context, the school context, and the language context. Regarding the everyday life context, three different subcategories were found: Connecting scientific and everyday phenomena, media references and telling a short story. Within the category of language context, two subcategories were identified: Connecting scientific and everyday words and derivation of words from other languages. The results from the categorization are found in Table 1. In all, 38 situations were considered to belong to the everyday life context, six to a wider school context and, 31 could refer to as to contextualization in relation to the language area.

### Contextualization at the Intersection between School Science and Everyday Life

All of the teachers connected school science to the everyday life context and nearly all did so through connecting scientific and everyday phenomena, which is the first sub-category in the everyday life context. The following excerpt (Excerpt 1) constitutes a typical example of contextualization found in the data material:

- **Excerpt 1**

Teacher: [Shows an experiment using an iron core, a coil, a magnet and an ampere meter] What does it mean when it tilts back and forth like this [shows with his arm how the magnetic field switches]? We have the north end always in one direction [pointing to the drawn coil on the whiteboard].

[...]

Teacher: Then, it becomes like this. When it is like this, the iron core is extended [showing on the coil on his desk], and we have the north end there and the south end there. Then [turns the magnet], the south end moves there and the north end there. The magnetic field in this moves back and forth, and then arises a phenomenon that creates power; it creates current. It moves here [to the measuring instrument], which is why it gives motion. And because of that, it switches back and forth, so it is alternating current. That is what we have in our wall switch [points toward the wall switch]. We get alternating current of this phenomenon. With the help of magnets, we create power, named induction. It is named induction. By induction, we have power in our wall switches. A simple generator has manufactured power through using induction.

In Excerpt 1, the teacher explains to the students how alternating current is created using an iron core and a coil. By

moving the core, he highlights how the magnetic field switches and power is generated. To emphasize the connection between his experiment and everyday life, he refers to the wall switches in the room, showing the importance of communicating the relevance of this scientific phenomenon. The students do not respond or comment on the teacher's statement.

Excerpt 2 shows another way of contextualizing at the intersection between the science content and everyday life. In this case, the teacher tells a story to highlight the scientific content. The teacher relates the discussed topic to popular science by sharing a short anecdote that involves how knowledge in science could be used in another science area. In so doing, the teacher introduces the concept of isotopes and relates it to how it is possible to determine the age of archaeological artefacts. In all, 12 situations were considered to belong to this category.

- **Excerpt 2**

Teacher: [The teacher draws three atomic models of hydrogen isotopes: Protium, deuterium, tritium, on the whiteboard]... it's still hydrogen. Hydrogen, mmmm, they have a special name, it's still hydrogen, but it is different isotopes. Different isotopes of hydrogen.

Student: What are isotopes?

Teacher: There are different kinds of hydrogen with different numbers of neutrons. All atoms have variations of different isotopes, but one isotope is more common. There is an isotope that has been found. All life contains that isotope. That's great because you can do research on it. For example, if I died, and someone dug me up in about a thousand years from now, then they could check one thing, and measure one thing, and then see that this guy, he died a thousand years ago.

Student: How can you see that?

Teacher: How can you see that?

Student: Carbon ... [inaudible]

Teacher: Something with carbon, yes. Carbon-14 method, like.

Student: We have heard about it.

Teacher: Yes, Carbon-14 is a carbon isotope. It is a kind of carbon has 14 in mass numbers.

Excerpt 2 highlights how the teacher explains the chemical concept of isotope and starts by listing the three isotopes of hydrogen. However, a student asks, "what are isotopes?" and the teacher answers by telling a short story. He does not really explain the concept and instead becomes engaged in

**Table 1: Contextualization described as the intersection between school science and the everyday life context, school context, or language context**

Context	Everyday life context	School context	Language context
Sub-context	Connecting scientific and everyday phenomena	Media; mass-media and movies	Tell a story/example
Number of situations	21	5	12
		Reference to other school subjects	Connects scientific and everyday words
		6	26
			Derivation of words from other languages
			5

an anecdote of what use there could be for knowing about isotopes in a context other than a chemical one. One student also confirms that this is something the student has heard. This indicates to the teacher that the students connect the discussed scientific content – in this case, the concept of isotopes – to an everyday life context. Furthermore, it is likely that this contextualization is created in the moment as the teacher uses the opportunity of a student's question to tell the short story.

### Contextualization at the Intersection between School Science and Other School Subjects

The second category found in this study concerned contextualization at the intersection between school science and other school subjects. At this intersection, the teacher made the science content relevant to the students by involving what is studied in other school subjects and referring to different angles of the same or similar phenomena. Considering the school context, one might expect that this intersection could be a common approach. However, we only identified six situations during the lesson introductions; Excerpt 3 provides an example of this:

#### • Excerpt 3

Teacher: Earth is our planet, like our address as well. And we've read quite a lot about the Earth in different contexts. You have read about it in physics about gravity, forces, and so on. You've read a lot about it in geography; everything is about Earth then. In biology, we have read about certain things, and when I talked about space, I talked about some parts and you have probably talked even more about this in primary school. [The teacher shows a collage of images related to astronomy on a PowerPoint slide.] Here are some pictures that you were taught. What do we see?

In Excerpt 3, the teacher emphasizes that learning about Earth in biology is related to learning about Earth in other school subjects, such as physics and geography. When the teacher says "physics," the teacher specifies and highlights that this could concern forces and gravity. The other school contexts are further enhanced through the images that are shown on the screen. It is likely that the teacher aimed to describe the content as one part of a larger domain and, in so doing, contextualize the science content through other school subjects. No students reacted to this statement.

### Contextualization at the Intersection between School Science and Language Perspectives

The final category of contextualization from lesson introductions found in this study considers how teachers use language perspectives or explanations related to a language domain to emphasize the scientific content. This approach comprises various ways of explaining the notion or derivation of words. The data material consists of 31 situations in which the teachers emphasize the language context in relation to science. As stated earlier, the content taught could have an impact on how teachers tend to use contextualizations. This is somewhat evident in this category as approximately one-third

of the coded situations are related to a teaching sequence about organic chemistry and translations of the names of organic acids into everyday names.

The following example (Excerpt 4) illustrates how the teacher involves a language context when explaining why the resistance is named "ohm"/ $\Omega$ , while developing the notion of omega and its relation to other languages. In all, the data comprises five situations in which the derivation of words from other languages is used to enhance the scientific content.

#### • Excerpt 4

Teacher: [Writes  $\Omega$  on the white board] This is the letter omega, and in the physics context, it means ohm... Omega, what letter is that?

Student 1: O.

Teacher: In what alphabet?

Student 1: The Greek.

Teacher: The Greek. There is the block capital Omega. There is uppercase. There is an expression in Swedish from A to ...?

Student 2: O.

Student 3: Ö [OE]

Teacher: From A to Ö [OE] and it is from the beginning to the end, and it came from the Greek [alphabet] because the last letter in the Greek alphabet is omega, O. Therefore, we say originally from A to O then, but it has changed. Think, in Danish, what would you say if it would take from A to Z, which is the Danish?

Student 4: A to Ö.

Teacher: No. Do you know what the last letter in the Danish alphabet is?

Student 3: Å [AA].

Teacher: It is called Å. They say X, Y, Z, Ä, Ö, Å, [X, Y, Z, AE, OE, AA].

In Excerpt 4, the teacher involves a short discussion about the origin of Omega and its meaning in the context of science and physics and in other contexts. It is likely the teacher aims to create a wider understanding of the sign omega and that the letter is used in contexts other than physics. The teacher also involves a third language, Danish, to emphasize the notion of "from A to O" or "from the beginning to the end". By engaging the students in this discussion, the teacher contextualizes the scientific content by emphasizing a language perspective.

The final example also concerns the school science content in relation to a language perspective but connects scientific words and everyday words. This means that the teacher highlights a scientific concept and refers to a synonym or an alternative explanation to consolidate the concept. In all, 26 situations were found in the data material where the teachers explained concepts with synonyms or alternative explanations. In Excerpt 5, the teacher focuses on concepts related to optics and uses different available resources to explicate the phenomenon of converging rays:

### • Excerpt 5

Teacher: [Draws a concave mirror with the light ray paths on the whiteboard] Concave mirror, then we also said something about this distance, this distance [pointing to the focal point]. It is called something, too. Denoted by a small *f*. And it is named? Molly?

Student (Molly): Focal point.

Teacher: Exactly.

[The teacher writes “focal point” on the board and draws an arrow to the focal point.]

Teacher: When light rays come in and are collected in this way [shows with his hands]. The light rays come together, it is named something as well, it is said that the light rays converge; that is, come together [writes “converge” on the whiteboard]. Converge, come together.

In this excerpt, the teacher first highlights the concept of focal point on the whiteboard. It appears that the students are somewhat familiar with this concept because a student (Molly) can answer the teacher’s question. Furthermore, the teacher involves the concept of converging and uses both the drawing and the everyday language of “come together” to broaden the understanding of the concept. Using both the physics language and everyday language, he creates possibilities for moving between the different contexts. The students do not engage in the teacher’s contextualization.

## DISCUSSION

The results from this study point to a variety of ways in which teachers use contextualization, specifically at the intersections between school science context and the context of everyday life, other school subjects, or language. Thus, the teachers tended to employ several different contexts to highlight and explain the scientific content in their lesson introductions. Some of the situations that are categorized here as contextualization are most likely created in the moment. This means that the teachers, seemingly without previously preparing to do so, can broaden the scientific contexts by adding supplementary contexts to clarify the discussed content. The results could be considered in line with Hashweh’s (1996) study, in which teachers described their own classroom practice mostly from a science content perspective without mentioning or integrating other contexts. From this viewpoint, the scientific content is in focus, but when additional explanations are needed, teachers adapt the learning situations to include contexts other than the scientific.

Nonetheless, it is possible to say that contextualization emerges on only a few occasions considering the nearly 8 h of analyzed material. It is also evident that the situations described in this study largely lack the depth in which contextualization is described in teaching models such as the cycle of contextualization, developed by Holbrook and Rannikmae (2010). The results from this study may support the feature clarification of the scientific content related to the

model for instruction by Feierabend and Eilks (2010), whereas the other four features are difficult to discern. Furthermore, the categories found in this study lack important features of SSI or inquiry-based teaching such as argumentation, ethical dilemmas, or inquiry. As argued in the background section, involving everyday life experiences and relating scientific content to other contexts could be considered an important way to make science personally relevant to the student, as well as to enhance students’ learning and interest in science (Crawford, 2000; Holbrook and Rannikmae 2010; National Research Council, 1986; Schmidt et al., 2019; Wierdsma et al., 2016). These methods of enriching the school science context have also proved important for students’ achievements in science (Schroeder et al., 2007). The language context category corresponds, to some extent, to Lemke’s (2000) discussion about learning the language of science, but the categorized situations in this study lack deeper aspects of, for example, hybridity, where the emphasis is on using multiple resources and different cultural or social aspects (Kamberelis and Wehunt, 2012; Wallace, 2004). From these results of contextualization in lesson introductions, there is a risk that students will develop limited abilities to move between different contexts such as the school science context and the everyday context. However, the present study only considers the lesson introductions and as argued in the methodological considerations, there are likely to be other teaching and learning activities that can support that ability. However, the study points to important possibilities for strengthening students’ knowledge and ability to make use scientific knowledge in different contexts.

When exploring how other contexts are integrated in school science, most previous studies have involved interventions and focused on how science teaching and learning are constituted when teachers attend certain programs or courses. This means that interventions in science classrooms have provided a learning environment that actively merges different contexts and clearly relates the scientific school context to those present in students’ everyday lives. When classroom interventions take place, it is important to develop teaching to use different contexts in explicit ways; research has shown that this supports students’ learning, positive attitudes toward science, and their science identity (Williams and Clement, 2015). To conduct the interventions, several resources in terms of time and tools are afforded to the classroom practice. This could be tools for teaching developed by a science education researcher, personal coaching during the teaching sequence, and/or a thorough report that provides assessment and reflections on possibilities and hindrances along the way to implementation. These resources probably far exceed the resources provided to teachers in general and could serve as a possible explanation of why the outcomes of intervention studies differ from this study using authentic situations. According to reports from the Swedish national agency for education (Skolverket, 2017) and the union Lärarförbundet (2013), most Swedish teachers experience high working loads and too little time to prepare for lessons. From a questionnaire answered by 2800 teachers

at the compulsory level (Läraryörbundet, 2013), the average amount of experienced preparation and follow-up time per week was 5 h, which is equivalent to approximately 15 min per lesson. When it comes to tools, the above-mentioned reports (Skolverket, 2017; Läraryörbundet, 2013) and other reports (OECD, 2017) point to the importance of professional development to enhance teaching and to provide and implement tools in classroom settings.

Without interventions, teachers take the opportunities to contextualize the science content to some extent, but these situations are rare compared to intervention studies. Furthermore, in the data material included in our overall research project, none of the science teachers approach an integrated or thematic science project. Therefore, it is likely that the tool of contextualization is not an obvious or self-evident way of conducting science teaching. Consequently, organizing the teaching setting to also involve contextualization could be an educational competence to be studied in professional development and in teacher education. Based on the results of this study and those of other research studies, there seems to be a strong need for an explicit focus on integrating school science with other contexts in both professional development and in teacher education. This study highlights authentic situations that could constitute background knowledge for developing tools communicated at learning platforms or in professional development. Furthermore, the background section of this paper highlights several theoretical models for approaching contextualization in science learning situations (Holbrook and Rannikmae, 2010; Weirdsma et al., 2016), which could serve as starting points for discussions about contextualization in areas such as professional development. To meet the demands of contextualizing learning activities to advance classroom practice, teachers need adequate planning time. However, there is a risk that Swedish teachers do not experience prerequisites in terms of planning time as sufficient for contextualizing their teaching. As discussed in the section of methodological considerations, the study comprises limitations in terms of, for example, student interactions and the difficulty of comparing city, urban and rural schools. Future studies could focus on these limitations but also explore prerequisites and attitudes for enhancing contextualization in classroom practice to bridge the gap between authentic classroom situations and good examples of interventions. As the present study has focused on teachers' way of contextualizing the science content, future research could also investigate students' responses to this approach.

### Limitations of the Study

This study is a first step to analyze how teachers use contextualization in authentic situations. We chose to concentrate on the lesson introductions, which only constitute one part of a lesson. This means that teachers' ways of contextualizing the content during parts other than the introductions are not captured. Another limitation of the study is that our approach does not involve how students respond to the teachers' engagements in contextualization. Consequently, students' discussions and activities related to contextualization

after the introductions and during the lessons are not analyzed. Since the focus is on the teachers, a third limitation is the difficulty to draw any conclusions regarding differences among urban, city and rural schools. The data material of fourteen teachers is too small. A focus on the students' activities could highlight possible differences.

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