The purpose of science education – Guidance provided by Swedish science syllabuses

Abstract
This study used a quantitative deductive approach based on Biesta’s functions of education and Roberts’ curriculum emphases to analyse the purposes that are stressed in the Swedish science syllabuses in lower and upper secondary school. The study shows that the syllabuses advocate multiple purposes both with respect to functions of education and curriculum emphases. Most sentences stressed the function of qualification, indicating that the overall purpose of science education is to provide students with knowledge and skills, while transmitting certain norms or creating independent critical thinking skills is less prioritised. The extent to which the different curriculum emphases were stressed differed both between different science syllabuses and between different parts of the syllabuses. Possible consequences of these differences are discussed in relation to teachers’ design of teaching and students’ possibilities to develop knowledge and skills necessary for active participation in science-related issues as citizens.

INTRODUCTION
Discussions about the purposes of science education have been going on since the beginning of the 19th century (DeBoer, 2000) and have taken place in many different contexts, for example, in national curricula, textbooks, and policy documents at international, national, and local school levels (Banner,
Donnelly, & Ryder, 2012; DeBoer, 2000; European Commission, 2015). In the discussions, a tension between two main purposes often becomes visible, namely whether science education should mainly focus on preparing students for future careers in science or for being responsible citizens sympathetic to the work of scientist (cf. DeBoer, 2000; European Commission, 2015; Roberts, 2007). This tension also includes discussions of whether, or how much, science education should focus on the personal level, such as knowledge to apply in everyday life, personal development, and interests (DeBoer, 2000; European Commission, 2015; Hultén, 2008). Multiple purposes are not necessarily negative, but a large diversity of purposes opens up for different interpretations and implementations of teaching (DeBoer, 2000; Lídar Karlberg, Almqvist, Östman, & Lundqvist, 2018) and can potentially risk the equality of science education. Distributing time among all various purposes might make science teaching too disconnected and fragmented (DeBoer, 2000). On the other hand, over-emphasising one purpose runs the risk of paying insufficient attention to other purposes (Roberts, 2007). Consequently, one could, for example, risk leaving some students out of science such as those wanting to pursue a scientific career or those wanting to work cross-disciplinarily with socioscientific issues.

In this article we describe a quantitative analysis of the purposes of science education expressed in the Swedish national syllabuses for science subjects in lower and upper secondary school (Figure 1). The functions of education (Biesta, 2009) and curriculum emphases (Roberts, 2007) were used to deepen the discussion of the purposes of science education and to explore what kind of qualification is brought forward and what values and norms are to be transmitted according to the syllabuses. In Sweden, all school forms have compulsory national syllabuses (National Agency for Education, 2018ab, 2020a) to use as a reference when planning, and teachers also report that the syllabus is important when implementing teaching (Wahlström & Sundberg, 2015). A problematisation of to what extent different purposes is expressed in the syllabuses could help teachers, curriculum developers, and policy makers to reflect on the intended purposes of science education. It could also feed the discussions of how the science syllabuses respond to recent calls to rethink education from a focus on scientific knowledge towards a more interdisciplinary teaching with a focus on skills and values that enable everyone to make informed decisions and to take action on local, national, and global urgencies (cf. Sjöström, Rauch, & Eilks, 2015; UNESCO, 2020).

The Purpose of Science Education

Because the question of why, and what, science students shall learn inherently relates to the overall purpose of education (Mansfield & Reiss, 2020), we will start this section by shortly reflecting on the general purpose of education in terms of the functions of education described by Biesta (2009, 2020). He claims that the question about the purpose of education is always raised in relation to three different functions of education: (1) qualification – to provide knowledge, skills, and understanding, (2) socialisation – to transmit certain values and norms, and (3) subjectification – to create independent and critical students (Biesta, 2009, 2020). These three functions are not to be considered as completely separate. Most, if not all, education includes all three functions, although the focus might differ (Biesta, 2009). All forms of education can be seen as practices of socialisation because they include interventions in a person’s life. It is not possible to ‘just’ give students knowledge; they will also be impacted as persons. After all, gaining knowledge will potentially empower the students (Biesta, 2020). Even though the functions are more or less inseparable, the balance between them might vary, and by being aware of these different major functions of education and by discussing the function that is most stressed in different educational contexts we can gain a better understanding of the overall purpose of each specific context (Biesta, 2009). For example, in teachers’ discussions about the purpose of education for sustainable development Hasslöf, Lundegård, and Malmberg (2016) found three partly overlapping discourses of qualification, namely qualification as scientific reasoning with a socialisation towards fact-based knowledge, qualification as an awareness of complexity, which enables room for subjectification, and qualification as being critical, with socialisation focused on students’ actions.

As mentioned in the introduction, in specific discussions about the purposes of science education a tension between two purposes often becomes visible. Roberts (2007) describes these two purposes
as Vision I, focusing on learning scientific content and scientific processes, and Vision II, focusing on contextualising science learning and on learning knowledge and skills necessary for using scientific knowledge in practical, existential, moral, and political contexts. These visions should be understood as abstractions of two extreme opposites, which in reality co-exist to varying degrees. In addition to these two purposes, researchers have used several other approaches when problematising the purposes of science education. For example, some researchers have suggested yet another vision, Vision III, also called critical scientific literacy, that is about “knowing in action” (Aikenhead, 2007; Hodson, 2009). Sjöström and Eilks (2018) have further elaborated on Vision III and connect it closely to the German term Bildung, which emphasises to critically identifying cultural presuppositions and to supporting alternative ways of thinking and acting in dialogue with the surrounding world (p. 73), as well as to Biesta’s subjectification. They incorporate a more pluralistic perspective of science education in Vision III, specifically in terms of science for transformation. In the contexts of education for sustainable development and environmental citizenship education, the importance for science education to use pedagogies that enable learners to develop knowledge and awareness and take action to transform society into a more sustainable one is specifically emphasised (Hadjichambis et al, 2020; UNESCO, 2020). A well-cited and detailed approach to describing the purposes of science education is as curriculum emphases (Roberts, 1982; Östman, 1995). According to Roberts (2007), Visions I and II materialise from the context in which science is taught. Roberts (1982) has chosen to call these contexts curriculum emphases, a coherent set of messages about the purpose of learning science. Seven curriculum emphases are described, namely Solid foundation, Correct explanation, Scientific skill development, Structure of science, Self as an explainer, Everyday coping, and Science technology and decisions (Roberts, 2007; Östman, 1995). Although there is a historical relationship between visions and curriculum emphases, there is no consensus on the exact nature of this relationship. For example, Roberts (2007) writes that Vision I incorporates Scientific skill development and Structure of science, while Lidar and co-authors (2018) include all emphases except Everyday coping and Science technology and decisions in Vision I. In this study the curriculum emphases are used together with Biesta’s (2009) functions of education as the analytical framework and are described in more detail in the method section.

The Role of the Swedish National Curriculum

Internationally, curricula usually frame wider perspectives of the educational steering system, such as cultural, philosophical, sociological perspectives, and they are used in a broad way to discuss significant values, norms, and knowledge for the educational system as well as how these should be organised, taught, and assessed (Englund, Forsberg, & Sundberg, 2012, Lundgren, 1989). In this study, we focus on the Swedish national curricula for lower and upper secondary school. These curricula are the formal written documents that regulate the formal written intentions of the school set by the policy makers and curriculum developers, also called the intended curriculum (Thijs & van den Akker, 2009). All education in lower and upper secondary school should be based on the national curricula (Swedish National Agency for Education, 2020a).

The Swedish national curricula are divided into two parts (Figure 1). The first part describes the school’s overall goals, values, norms, and knowledge that are essential to society. For example, in Swedish national curriculum for upper secondary school (Swedish National Agency for Education, 2011a) it is stated that students should be provided insights so that they can not only contribute to preventing harmful environmental effects, but also develop a personal approach to overarching, global environmental issues (p. 6) and that all students at higher education preparatory programmes should be well prepared for studies in higher education (p. 8). The second part of the curricula consists of syllabuses for all school subjects. These describe what should be taught in terms of aims and core content, and the specific knowledge requirements for every school subject. The aim and the core content are to be used when planning the teaching, and the knowledge requirements describe the kind of knowledge and skills that will be assessed at the end of a course (Swedish National Agency for Education, 2020a). However, the syllabuses do not state how core content and aims should be combined or how much time should be allocated to specific aims or content.
The Swedish national curricula have been used as the instrument for governance and control in the school system and as an instrument for the implementation of educational reforms (Lundgren, 2015). The current national curricula for the compulsory school, preschool class, and the recreation centre, Lgr11, and for upper secondary school, Lgy11 (Swedish National Agency for Education, 2011abc) were introduced in 2011. The ambition of the implementation was to increase the governing/steering power of the curricula, to enhance the clarity and concretisation of the curricula, and to increase the equality in teaching and assessing (SOU 2007:28).

Several studies have shown that the syllabuses have an important role for Swedish teachers’ planning and implementation of teaching (Swedish National Agency for Education, 2018ab; Wahlström & Sundberg, 2015). Teachers report that the core content is the foundation that is actively used when planning education (Swedish National Agency for Education, 2018a). The knowledge requirements also play an important role, especially for courses where teachers shall grade students at the end (Swedish National Agency for Education, 2018ab; Wahlström & Sundberg, 2015), while the aim is usually reported to serve as a background, something one reads once a year but does not use actively in day-to-day planning (Swedish National Agency for Education, 2018a). Besides syllabuses, other factors such as experience, student interest, national tests, leadership, collegial atmosphere, and teaching material also affect teachers’ planning and implementation (Ryder & Banner, 2013; Swedish National Agency for Education, 2018ab). In several studies science teachers have specifically reported that they prioritise factual knowledge and neutral perspectives on environmental issues over abilities and the inclusion of socioscientific issues (Borg et al., 2012; Hofstein, Eilks, & Bybee, 2011; Ryder & Banner, 2013; Sund & Gericke, 2020), indicating that all purposes mentioned in the syllabuses are not equally prioritised. A recent study did however show that physics teachers were positive towards teaching fundamental physics and knowledge development in physics as well as about physics, technology, and society (Hansson, Hansson, Juter, & Redfors, 2020).

The Swedish national curricula are known to include several different purposes for education; however, specific studies of which purposes are more or less stressed in the Swedish science syllabuses is few. In a study of the treatment of energy quality in the curricula between 1962 and 2011, Haglund and Hultén (2017) showed that although Vision II and III have increased since 1980, Vision I was still dominant in the physics syllabus in the 1994 revision. Further, they found a tension between the first parts of the curriculum and the syllabus, where the curriculum stresses Vision II and the syllabus is

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**Figure 1. Schematic picture of the structure of Swedish national curricula.**

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<table>
<thead>
<tr>
<th>Part 1</th>
<th>Fundamental Values and Tasks of the School</th>
<th>Overall Goals and Guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 2</td>
<td>Syllabuses for individual school subjects</td>
<td></td>
</tr>
<tr>
<td>Aim</td>
<td>Overall long-term goals of the school subject.</td>
<td></td>
</tr>
<tr>
<td>Core content</td>
<td>Teaching topics in the specific school subject.</td>
<td></td>
</tr>
<tr>
<td>Knowledge requirements</td>
<td>Assessment guidelines for the final grades (A – F).</td>
<td></td>
</tr>
</tbody>
</table>

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Knekta, Almarlind and Ottander
dominated by Vision I (Haglund & Hultén, 2017). They conclude that this incoherence can cause diffic-
dulties for teachers when implementing the curriculum. According to on-going curricula revisions,
there will be increased emphasis on factual knowledge in compulsory school syllabuses (Swedish Na-
tional Agency for Education, 2020b), thus it appears that Vision I could become even more dominant.
In a study of physics syllabuses, Marty, Venturini, and Almqvist (2018) found that the Swedish phys-
ics syllabuses expressed several different purposes but were relatively consistent with respect to what
purposes are expressed in the different parts of the syllabuses. Haglund and Hultén (2017) and Marty
and co-authors (2018) used a holistic approach when analysing the syllabuses. To the best of our
knowledge there has been no quantitative study showing the distribution of the purposes of science
education in Sweden as expressed in the current syllabuses for science subjects in lower and upper
secondary school. We argue that the number of sentences stressing the different purposes can impact
how the curriculum is interpreted by the teachers and implemented in practice (i.e., the implemented
curriculum; Thijs & van den Akker, 2009). If most sentences stress a specific purpose and only a
few stresses another, this will probably affect the qualitative interpretation of the syllabuses and the
implemented curriculum.

Aim and Research Questions
The aim of this study was to increase the knowledge of the guidance provided by the Swedish syl-
labuses with respect to the purpose of science education. This is done by analysing each sentence
in the science syllabuses using the three functions of education – qualification, socialisation, and
subjectification – developed by Biesta (2009), and the seven curriculum emphases – developed by
Roberts (1982).

The specific research questions were:

1. To what extent are different functions of education and curriculum emphases stressed in the
   science syllabuses?
2. How does the distribution of educational functions and curriculum emphases change in the
   transition from lower secondary school to the different programmes in upper secondary
   schools?

METHODS
Deductive semantic content analysis (Braun & Clarke, 2006; Krippendorff, 2004) was used to analyse
how sentences stressing different functions and curriculum emphases are distributed in the Swedish
science syllabuses.

Material
In lower secondary school, all students take the same science courses of biology, chemistry, and phys-
ics (Figure 2). Syllabuses for each of these subjects were chosen for analysis. In upper secondary
school, students follow different science courses depending on the programme they choose to study
(Figure 2). For this study, the biology, chemistry, and physics syllabuses for the mandatory science
courses in the science programme (course 1 in each subject) and the science studies syllabus for the
mandatory science course in other theoretical programmes (course 1b), all with 100 course credits,
were chosen for analysis.
The content of the biology, chemistry, and physics syllabuses is relatively closely connected to their corresponding academic subjects. Science studies is interdisciplinary with a foundation in biology, chemistry, physics, and earth science but also incorporates social science. The biology, chemistry, and physics syllabuses have a total of between 53 and 68 sentences (Table 1). The main differences, with respect to both content and number of sentences, between biology, chemistry, and physics within lower and upper secondary school are found in the core content. The number of sentences and the content in the science studies syllabus differ significantly from the biology, chemistry, and physics syllabuses. In the following text, biology, chemistry, and physics will collectively be referred to as the science subjects.

Table 1. Number of sentences in each syllabus, in total, and the different parts of the syllabus

<table>
<thead>
<tr>
<th></th>
<th>Lower secondary school</th>
<th>Upper secondary school</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Biology</td>
<td>Chemistry</td>
</tr>
<tr>
<td>Aim</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td>Core content</td>
<td>31</td>
<td>30</td>
</tr>
<tr>
<td>Knowledge requirements</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Total</td>
<td>64</td>
<td>63</td>
</tr>
</tbody>
</table>

Analytical Framework
We chose to use functions of education (Biesta, 2009, 2011) and curriculum emphases (Roberts 1982, 1998, 2007, Wikman & Persson, 2009; Östman, 1995, 2014) to analyse the syllabuses. The functions were used to gain an initial overall picture of the extent to which scientific knowledge (qualification),
values and norms (socialisation), and independent critical thinking (subjectification) are stressed in the syllabuses. Curriculum emphases were then used to gain a more in-depth understanding of the functions, to describe what kind of qualification is brought forward and what values and norms are to be transmitted. Using the curriculum emphases also enabled us to discover and make visible the more implicit socialisation functions. A description of what is expressed and what is not expressed in the syllabuses could collectively symbolise certain intended values. The following seven curriculum emphases were used: (1) Correct explanation, learning the correct interpretation of the world, (2) Structure of science, knowing how scientific knowledge is created and how it differs from other sciences, (3) Scientific skills development, learning the skills needed to perform scientific investigations, (4) Everyday coping, knowing how to apply scientific knowledge to societal problems and in everyday life, (5) Science, technology, and decisions, knowing how to use scientific knowledge for decision-making, (6) Solid foundation, to prepare for studies on a higher level, and (7) Interest, students’ own understanding of, experience of, interest in, and ability to explain nature and the material world.

For the curriculum emphasis Interest, some clarification of our interpretation is needed. There were a few sentences in the syllabuses concerning the historical perspectives of the subjects. For example, Historical and contemporary discoveries in the area of chemistry and their importance for a world view, technology, the environment, society, and people’s living conditions (Lgr11, p. 192) and Development of biology with emphasis on evolution (syllabus for biology in upper secondary school, p. 3). In our view, these focused more on how scientific knowledge is created (Structure of science; Roberts, 1998) than using history as a means of facilitating the students’ learning and understanding of the context in which scientific knowledge is developed (Self as an explainer; Roberts, 1998; Östman, 1995). Eventually, all sentences included in the Self as an explainer category concerned learning science because it is interesting to engage feelings and to learn science based on the students’ own experiences. We therefore chose to rename the curriculum emphasis Self as an explainer to Interest in this particular study.

Our operationalisation of the functions of education and the curriculum emphases is described in detail in a code book comprising three parts: (1) descriptions of our interpretation of each function and emphasis, (2) examples of sentences clearly belonging to each function and emphasis, and (3) examples of sentences that were difficult to code but were still decided to belong to the actual function/emphasis, and general guidelines on how to code (see Supplemental material).

Analytical Procedure
The analysis of the syllabuses was conducted iteratively (Figure 3). First, two of the researchers developed a preliminary code book based on the literature, individual coding, and common discussions. Second, a third researcher coded half of the material, and refinement of the code book was made based on common discussions and individual coding. This process was repeated until agreement among all three researchers about the coding was reached.
The coding principle was to read each sentence in isolation and analyse what it explicitly stated. If being very inclusive in the interpretation of each sentence, almost all functions and curriculum emphases could be found in each sentence. For example, learning how to use something in your everyday life (Everyday coping) might also be interesting (Interest). Also, as mentioned above, all forms of education can be seen as practices of socialisation because they include interventions in a person’s life. Therefore, we deemed that placing each sentence in only one function of education and one curriculum emphasis based on what the sentence stressed would give the most appropriate picture of the guidance the syllabuses give with respect to the purpose of science education. Each sentence was given equal weight, hence potential nuances in the meaning of a sentence, depending on, for example, length and position, were not accounted for. Our method should therefore be seen as a complement and not an alternative to more holistic approaches. To enable critical reviewing and replication of our study, we present our code book in the Supplemental Material and offer a document showing the complete coding for the chemistry syllabus upon request from the corresponding author.

The results of the coding were analysed by calculating both the amount and frequency of sentences stressing each function and curriculum emphasis, in total in each syllabus as well as in the different parts (aim, core content, and knowledge requirements).

RESULTS
In the result section, we will describe the distribution of sentences first with regards to functions of education and then with regard to curriculum emphases. Findings regarding curriculum emphases in chemistry, biology, and physics within lower and upper secondary school are primarily illustrated in tables and figures with the results from the chemistry syllabus.
The Functions of Science Education

In all analysed syllabuses, both in lower and upper secondary school, most sentences stress qualification (Table 2). Only a few sentences stress socialisation and subjectification.

Table 2. Distribution of different functions in the syllabuses presented as numbers of sentences

<table>
<thead>
<tr>
<th>The functions of education</th>
<th>Qualification</th>
<th>Socialisation</th>
<th>Subjectification</th>
<th>Difficult to categorise</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lower secondary school</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biology</td>
<td>57</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Chemistry</td>
<td>58</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Physics</td>
<td>63</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td><strong>Upper secondary school</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biology</td>
<td>60</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Chemistry</td>
<td>45</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Physics</td>
<td>59</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Science Studies</td>
<td>29</td>
<td>4</td>
<td>7</td>
<td>0</td>
</tr>
</tbody>
</table>

a = All science subjects in both lower and upper secondary school had two sentences that were difficult to code. The difficulty was in deciding which function the sentences should belong to when they stress interest and curiosity. One example is: The sciences have their origins in man’s curiosity and the need to know more about ourselves and the surrounding world. (Lgr11, p. 177).

In lower secondary school, all subjects have a sentence in the aim coded as socialisation, that is, fostering students to contribute to sustainable development: Knowledge about the structure and destructibility of matter provides people with the tools to be able to contribute to sustainable development (Lgr11, p. 188). In upper secondary school, only biology has a sentence about contributing to sustainability (found in the core content). All syllabuses in upper secondary school have a sentence in the aim coded as socialising students into a scientific mode of thinking: Teaching should give students the opportunity to develop a scientific approach to the surrounding world (Lgy11, 2011b, p. 1). In the biology syllabus in lower secondary school and science studies syllabus in upper secondary school, a few additional sentences in the core content and the aim were coded as socialisation. These sentences consider identity, gender equality, relationships, love and responsibility, or ethical approaches to different scientific methods.
Generally, the syllabuses include more sentences stressing *subjectification* compared to *socialisation* (Table 2). Three sentences each in biology, chemistry, and physics in both lower and upper secondary school focus on *subjectification* (found in all parts of the syllabus in upper secondary school and in the aim and knowledge requirements in lower secondary school). They all concern taking a view based on a scientific approach:

*Teaching in chemistry should essentially give pupils the opportunities to develop their ability to use knowledge of chemistry to examine information, communicate and take a view on questions concerning energy, the environment, health and society.* (Lgr11, p. 188)

In the science studies syllabus, eight sentences focus on *subjectification* (found in all parts of the syllabus). Like the other syllabuses, most of these sentences are about taking a view based on knowledge of science. However, some sentences in the science studies syllabus incorporate views in a more interdisciplinary context and also place a stronger emphasis on action competence and the ability to influence: *The ability to use knowledge of science to discuss, form views and formulate different courses of action.* (Syllabus for science studies, p. 1).

**Curriculum emphases**

Most curriculum emphases are represented in all the analysed syllabuses. However, the curriculum emphasis *Interest* is missing in the science studies syllabus, and the curriculum emphasis *Solid foundation* (learning science in order to prepare for studies on a higher level) was not found in any of the analysed syllabuses.

*Distribution within science subjects in lower secondary school*

In total, the curriculum emphases *Correct explanation* (24%), *Structure of science* (20%), and *Scientific skill development* (20%) are the three most common curriculum emphases in the science subject syllabuses in lower secondary school (Table 3). The least common curriculum emphases are *Science, technology and decisions* (15%) and *Interest* (5%).

**Table 3. Distribution (%) of curriculum emphases in the chemistry syllabus in lower secondary school**

<table>
<thead>
<tr>
<th></th>
<th>Aim</th>
<th>Core content</th>
<th>Knowledge requirements</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Correct explanation</em></td>
<td>14</td>
<td>35</td>
<td>14</td>
<td>24</td>
</tr>
<tr>
<td><em>Structure of science</em></td>
<td>29</td>
<td>16</td>
<td>14</td>
<td>20</td>
</tr>
<tr>
<td><em>Interest</em></td>
<td>14</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td><em>Scientific skill development</em></td>
<td>19</td>
<td>13</td>
<td>36</td>
<td>20</td>
</tr>
<tr>
<td><em>Everyday coping</em></td>
<td>5</td>
<td>26</td>
<td>14</td>
<td>17</td>
</tr>
<tr>
<td><em>Science, technology and decisions</em></td>
<td>19</td>
<td>10</td>
<td>21</td>
<td>15</td>
</tr>
</tbody>
</table>

Note. One sentence equals 5% in the aim, 3% in the core content, 7% in the knowledge requirement, and 1.7% in total.
The curriculum emphases are distributed differently in the different parts of the syllabus (Table 3). In the aim, Structure of science is the most common (29%); in the core content, Correct explanation is the most common (35%); and in the knowledge requirements, Scientific skill development is the most common (36%). The curriculum emphasis Interest is only found in the aim in the science subjects. Everyday coping is the least common curriculum emphasis in the aim (5%) but the second most common emphasis in the core content.

Overall, the science subject syllabuses in lower secondary school are similar to each other with respect to the distribution of curriculum emphases (Figure 4). The physics and chemistry core content do, however, include more sentences stressing Everyday coping compared to the core content in biology, while Science, technology and decisions is more represented in the core content in biology.

**Distribution within science subjects in upper secondary school**

As for lower secondary school, the curriculum emphases Correct explanation (24%), Structure of science (30%), and Scientific skill development (29%) are the three most common curriculum emphases in the science subject syllabuses in upper secondary school (Table 4). The other three curriculum emphases have a much lower representation (3%–10%).

**Table 4. Distribution (%) of curriculum emphases in the chemistry syllabus in upper secondary school**

<table>
<thead>
<tr>
<th></th>
<th>Aim</th>
<th>Core content</th>
<th>Knowledge requirements</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correct explanation</td>
<td>19</td>
<td>44</td>
<td>14</td>
<td>24</td>
</tr>
<tr>
<td>Structure of science</td>
<td>31</td>
<td>31</td>
<td>29</td>
<td>30</td>
</tr>
<tr>
<td>Interest</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Scientific skill development</td>
<td>27</td>
<td>19</td>
<td>38</td>
<td>29</td>
</tr>
<tr>
<td>Everyday coping</td>
<td>12</td>
<td>0</td>
<td>14</td>
<td>10</td>
</tr>
<tr>
<td>Science, technology and decisions</td>
<td>4</td>
<td>6</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

Note. One sentence equals 4% in the aim, 6% in the core content, 5% in the knowledge requirements, and 1.5% in total.

Also, in upper secondary school the distribution of sentences regarding the different curriculum emphases differs between the different parts of the syllabus. In the aim, Structure of science (30%) and Scientific skill development (27%) are the most common; in the core content, Correct explanation is the most common (44%); and in the knowledge requirements, Scientific skill development (38%) is the most common.

Overall, the science subject syllabuses in upper secondary school are similar to each other with respect to the distribution of curriculum emphases (Figure 4). The physics core content does, however, include more sentences stressing the Correct explanation and Everyday coping compared to the two other subjects. Scientific skill development is more common in the biology core content, while Structure of Science is more common in the chemistry core content compared to the two other subjects.
Distribution within science studies in upper secondary school

The distribution of curriculum emphases in the Science Studies syllabus differs from the distribution in the science subjects. Sentences categorised as *Science, technology and decisions* are the most common in the science studies syllabus (48%; Table 5). The other curriculum emphases have a lower representation (0%–18%; Table 5).

Table 5. Distribution (%) of curriculum emphases in the science studies syllabus

<table>
<thead>
<tr>
<th></th>
<th>Aim</th>
<th>Core content</th>
<th>Knowledge requirements</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correct explanation</td>
<td>12</td>
<td>17</td>
<td>9</td>
<td>12</td>
</tr>
<tr>
<td>Structure of science</td>
<td>18</td>
<td>17</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Interest</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Scientific skill develop</td>
<td>6</td>
<td>8</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Everyday coping</td>
<td>18</td>
<td>0</td>
<td>27</td>
<td>15</td>
</tr>
<tr>
<td>Science, technology and decisions</td>
<td>47</td>
<td>58</td>
<td>36</td>
<td>48</td>
</tr>
</tbody>
</table>

Note. One sentence equals 6% in the aim, 8% in the core content, 9% in the knowledge requirements, and 2.7% in total.

The distribution of sentences regarding curriculum emphases is similar in the different parts of the science studies syllabus, except for the curriculum emphasis *Everyday coping*, for which no sentence is found in the core content.

A comparison between the science studies and the science subject syllabuses showed that sometimes sentences in the different syllabuses concern the same content but the content is placed in a different context. For example, the aim in science studies states: *Knowledge of the significance of scientific theory for the development of societies and people's worldview.* (p. 1), while the aim in chemistry states: *Knowledge of chemical concepts, models, theories and working methods, and understanding their development.* (p. 1). Both include knowledge about the nature of science, although in science studies the emphasis is on the development of society and people’s world view and in chemistry the emphasis is on the development of the theories themselves. Likewise, the aim in the science studies syllabus states: *Knowledge of the role of science in current social issues and in relation to sustainable development* (p. 1), while in chemistry it states: *Knowledge of the importance of chemistry for the individual and society* (p. 2). Both concern the importance of scientific knowledge, although in science studies it is placed in a more complex societal context. Sometimes the context of a content even shifts the curriculum emphasis. For example, in the core content in the science studies syllabus, ethical perspectives of scientific methods are mentioned: *Working methods of science, such as observation, classification, measurement and experimentation, and ethical perspectives related to scientific exploration.* (p. 3; categorised as *Science, technology and decisions*), while ethical perspectives of scientific methods they are not mentioned in any of the syllabuses of the science subjects. Instead, sentences concerning scientific methods are decontextualised: *Planning and carrying out experiments and formulating and testing hypotheses related to these.* (p. 3; categorised as *Scientific skill development*).
ANALYSIS AND DISCUSSION

This study aimed to quantitatively analyse the guidance provided by the Swedish science syllabuses with respect to the purpose of science education. Problematisations of these syllabuses are relevant because they are important for teachers’ planning and implementation of teaching (Swedish National Agency for Education, 2018ab, 2020a), and the multiple potential purposes of science education open up for different interpretations and implementation of teaching (DeBoer, 2000; Lidar Karlberg, Almqvist, Östman, & Lundqvist, 2018), which can potentially risk the equality of science education.

Qualification is the Most Common Function of Science Education

Our analysis showed that the vast majority of the sentences in the science syllabuses stress qualification and only a few sentences explicitly stress socialisation and subjectification. In all syllabuses in upper secondary school, one sentence stresses socialisation towards a scientific way of thinking (classified as Structure of science). In all the lower secondary school syllabuses, in the biology syllabus at upper secondary school, and in the science studies syllabus, a few sentences coded as socialisation concern gender equality, norms, or environmental responsibility (categorised as Science, technology and decisions). All sentences coded as subjectification were also coded as Science, technology and decisions taking a view based on a scientific approach (all syllabuses) and using more interdisciplinary approaches (science studies syllabus). When contrasting our results concerning the functions of education stressed in the syllabuses with the content in part 1 of the curricula (Swedish National Agency for Education, 2011ac), it can be seen that in alignment with studies by Sporre (2018) and Haglund and Hultén (2017), that many of the values and norms in part 1 (e.g., equal opportunities, influence of students, responsible attitude towards digital technology) are invisible in the syllabuses. Thus, if education is planned mainly based on the syllabuses, the deeper meaning of the whole curricula might get lost, and one could end up with a plan explicitly focusing on qualification. However, education is inherently always socialising (Biesta, 2009). In the next section, the distribution of the curriculum emphases in the syllabuses is discussed, which will give us a sense of the implicit socialising message from the syllabuses.
The Curriculum Emphases are Stressed to Different Extents Between the Syllabuses

Within the qualification function, all curriculum emphases, except Solid foundation, are found. Further, with a few exceptions, all curriculum emphases are represented in every syllabus and in all parts of the syllabuses. In that sense our results are in accordance with the conclusion of Marty and co-authors (2018) that the Swedish physics syllabus expresses several different purposes and is relatively consistent with respect to the purposes that are expressed in the different parts of the syllabuses. Our quantitative analysis did, however, reveal differences in the extent to which the different curriculum emphases were represented.

Our analysis found that in the transition from lower to upper secondary school the purposes of science education are described differently for students in science and technology programmes studying science subjects compared to students on other programmes studying science studies. For students entering science and technology programmes, the curriculum emphases Correct explanation, Scientific skill development, and Structure of science increase from 64% of all sentences to 83% in the science subject syllabuses. At the same time Science, technology and decision decreases from 15% to 5%. For students in other programmes (i.e., following the science studies syllabus) there is instead a focus on Science, technology and decisions (48%), including sentences focusing on, for example, sustainable development, ethical approaches to scientific methods, and taking a stand based on an interdisciplinary and scientific way of thinking. Furthermore, in the science subjects syllabuses scientific knowledge is expressed in a rather decontextualised manner, while in science studies syllabus the same knowledge is placed in more socioscientific contexts. Together these observations can be interpreted to mean that the implicit message to students in science and technology programmes is that they should be qualified with disciplinary knowledge and socialised into a scientific way of thinking or into a future career in the science field, while interdisciplinary knowledge, skills, values, and attitudes that enable them to make informed decisions and to take individual and collective action is less prioritised. On the other hand, the implicit message to students in other programmes than science and technology suggests that these latter abilities are important, and the main purpose for science education is to socialise them to be responsible and active citizens. It is uncontroversial that students in science and technology programmes will need to develop a deeper science content knowledge and learn the skills necessary to perform reliable scientific investigations to be prepared for further scientific studies. However, science teachers' general tendency to prioritise factual knowledge and neutral perspectives on environmental issues over abilities and inclusion of socioscientific issues (Borg et al., 2012; Hofstein et al. 2011; Ryder & Banner, 2013) in combination with syllabuses mainly stressing scientific content and skills increases the probability that students in science and technology programmes might miss out on opportunities to acquire the skills needed to apply scientific knowledge for taking individual and collective action. These are skills all students are entitled to acquire (UNESCO, 2020). Burmeister, Rauch, and Eilks (2012) argue that development of general skills necessary for discussing socioscientific issues will hardly have the chance to emerge if teaching is primarily focused on scientific content. On the other hand, some teachers and policymakers argue that students who receive a strong focus on socioscientific issues might not acquire enough factual knowledge to apply such knowledge to society and to their everyday lives (Hughes, 2000; Pouliot, 2008). Research exploring the relationship between having content knowledge and the ability to apply it to socioscientific issues is not straightforward (Cetin, Dogan, & Kutluca, 2014; Zeidler, 2014). Some studies suggest a positive relationship between the quality of socioscientific reasoning and the level of content knowledge (Sadler, Romnie, Topçu, & Sami, 2016), while others present contradictory and more complex relations (Nielsen 2012; Lewis & Leach, 2006; Ziedler, 2014). However, research has more consistently shown the possibility of learning content knowledge, socioscientific reasoning, and decision making simultaneously, thus supporting education focusing on Everyday coping and Science, technology and decisions (e.g. Lee & Grace, 2012; Grace, 2009; Sadler, Barab & Scott, 2007). Further, finding a subject personally relevant has been shown to be predictive of effort, interest, and educational trajectory (Priniski, Hecht & Harackiewicz, 2018). In this context it is noteworthy that the science studies syllabus in our study is the only syllabus wherein interest is not explicitly mentioned. To promote basic interest in science might be particularly important for students who, in the future,
probably will not pursue a career in science (Hofstein et al., 2011). Although their main interest is within another area, they will still need to function as literate citizens on issues related to science and maybe collaborate with scientists in cross-disciplinary issues.

The Curriculum Emphases are Stressed to Different Extents within the Syllabuses

Our study also found differences in the extent to which different curriculum emphases were expressed in the aim, core content, and knowledge requirements in the science subject syllabuses. For both lower and upper secondary school, Correct explanation was stressed to a greater degree in the core content compared to aim and knowledge requirements. Even though the Swedish National Agency for Education (2020a) states that the aim and the core content shall be used when planning teaching, the teachers report that the core content alone is the foundation for Swedish teachers’ planning (The Swedish National Agency for Education, 2018a). Further, a common perception on the part of science teachers is that they have to cover a certain amount of content (DeBoer, 2000, Ryder & Banner, 2013). If the core content is used as a checklist of content to be covered rather than read holistically together with the aim, then the number of sentences stressing different curriculum emphases in the core content will matter and teaching will risk mainly focusing on disciplinary facts with weak relations to major contexts. On the other hand, if the knowledge requirements become too focused during planning, Scientific skill development might become dominant. Both the low occurrence of sentences in the syllabuses explicitly stressing the socialising and subjectification function of education and the variation of the extent to which different curriculum emphases are expressed in the different parts of the syllabuses show the importance of using the curricula as a whole when planning the teaching. More specifically, if the intention of the Swedish National Agency for Education (2020a) that the first part of the curricula and the aim and the core content together should guide the teaching is not followed, this might affect the main direction of the teaching.

Conclusions and Future Research

Our study uncovered quantitative differences in the extent to which different functions of education and curriculum emphases are stressed between the science subject and the science studies syllabuses. These differences suggest that the main purpose of science education for students in science and technology programmes is to socialise them into a scientific way of thinking. Meanwhile the science studies syllabus that is compulsory for students in other programmes better reflects UNESCO’s (2020) call to rethink education towards pedagogies that foster independent citizens that are able to transform society into a more sustainable one. Further, our study found quantitative differences in the extent to which different curriculum emphases are stressed in the aim, core content, and knowledge requirements in the science subject syllabuses. We argue that all these differences need to be acknowledged and problematised among teachers and policy makers in terms of what they mean and how they should be interpreted. Opportunities for critical collegial reflection of the intentions of the syllabuses increases the possibility for a successful implementation of the curricula (Ryder, 2015). This can increase both teachers’ feeling of autonomy over their own practise and the equality of science education.

The aim of this study was to analyse the intended steering documents. Thus, we cannot draw any conclusions about the implemented or the assessed curriculum. In future studies it would be interesting to use our approach to study the messages conveyed by other key educational documents, such as the national tests in science or science textbooks, with respect to the purpose of science education. Further, it would be interesting to explore more closely how the different numbers of sentences focusing on different purposes in the syllabuses appear to impact teaching practice, as well as the students’ interest and perceived ability in science and in active participation with science-related issues as citizens.
REFERENCES


SUPPLEMENTAL MATERIAL

Code book
Below follows the code book used to code the sentences in the syllabuses included in this study. The code book includes a description of our understanding of the three general functions of education; qualification, socialization and subjectification, described by Biesta (2009, 2011) and the seven curriculum emphases described by Roberts (1982, 1998, 2007), Wickman & Persson (2009) and Östman (1995, 2014), examples of sentences clearly belonging to each function and curriculum emphasis, example of borderline sentences difficult to code but still decided to belong to the actual function/curriculum emphasis, and general guidelines on how to code. A document showing the complete coding for the Chemistry syllabus is available on request from the corresponding author.

Table 1. The functions of education (Biesta, 2009, 2011), including a description of the functions, example sentences and borderline sentences from the Science studies syllabus and the syllabuses in Chemistry, Biology and Physics for lower and upper secondary school

<table>
<thead>
<tr>
<th>Functions of Education</th>
<th>Operationalization of each function</th>
<th>Examples sentences</th>
<th>Examples of borderline sentences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qualification</td>
<td>The function of teaching is to provide students with the knowledge, abilities and skills needed in society and working life. For example, to learn; about democracy, about the human body parts, its name and about function or the characteristics of a scientific question.</td>
<td>Processes for purifying drinking water and wastewater, locally and globally. (Core content, Lgr11, p.192)</td>
<td>Teaching should cover scientific working methods, such as formulating and searching for answers, making systematic observations, planning and carrying out experiments and field studies, as well as processing, interpreting and critically assessing results and information. (Aim, Lgy11, p.1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>How physical and mental health is affected by sleep, diet, exercise, social relationships and addictive substances. (Core content, Lgr11, p.170)</td>
<td>Teaching should also help students develop the ability to critically assess and distinguish between statements based on scientific and non-scientific foundations. (Aim, Lgy11, p.1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Critical examination of sources of information and arguments encountered by pupils in different sources and social discussions related to biology, in both digital and other media. (Core content, Lgr11, p.170)</td>
<td>Comment: Although the sentences stress critical assessing results and statements they are not about critical thinking against prevailing norms.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Teaching should give students the opportunity to develop a scientific approach to the surrounding world. (Aim, Lgy11, p.)</td>
<td>Teaching should give pupils opportunities to use and develop knowledge and tools for expressing their own arguments and examining those of others in contexts where knowledge of biology is of importance. (Aim, Lgr11, p.166)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Human puberty, sexuality and reproduction and also questions about identity, gender equality, relationships, love and responsibility. (Core content, Lgr11, p.170)</td>
<td>Comment: Having tools to express own arguments was not deemed strong enough to be considered as subjectification.</td>
</tr>
<tr>
<td>Socialisation</td>
<td>The function of teaching is to socialize young people into the norms of the prevailing society, that is, to transfer prevailing values (e.g., gender equality, cultural diversity) and behaviours that are necessary for the survival of society. Young people become involved in a particular social, cultural or political culture. Example of values or behaviours to be transferred are: take responsibility, actively participate or contribute, or developing a scientific way of thinking.</td>
<td>Teaching should give students the opportunity to develop a scientific approach to the surrounding world. (Aim, Lgy11, p.)</td>
<td>Scientific aspects, reflection on and discussion of norms concerning human sexuality, sexual desire, relationships and sexual health. (Core content, Lgy11, 3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Human puberty, sexuality and reproduction and also questions about identity, gender equality, relationships, love and responsibility. (Core content, Lgr11, p.170)</td>
<td>Comment: Reflection about norm was considered as indicative of socialisation.</td>
</tr>
</tbody>
</table>
The function of teaching is that students should become their own subjects, that they can change both their own lives and societal structures as society changes. They must also be able to drive change, that is, be critical of prevailing conditions and put forward new ideas. Education gives the individual the power to break free from prevailing norms and create their own identity.

Being critical in general is not subjectification but being critical against current norms is. Taking a view is always subjectification.

Determining views on social issues on the basis of chemical models, e.g. sustainable development issues. (Core content, Lgy11, p.3)

<table>
<thead>
<tr>
<th>Subjectification</th>
<th>Determining views on social issues on the basis of chemical models, e.g. sustainable development issues. (Core content, Lgy11, p.3)</th>
</tr>
</thead>
</table>

### Table 2. The curriculum emphases (Roberts, 1982, 1998, 2007; Wickman & Persson, 2009; Östman, 1995, 2014), including a description of the curriculum emphases, example sentences and borderline sentences from the syllabuses in Chemistry, Biology and Physics for lower and upper secondary school

<table>
<thead>
<tr>
<th>Curriculum emphases</th>
<th>Operationalization of each curriculum emphases</th>
<th>Examples sentences</th>
<th>Examples of borderline sentences</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Correct explanation</strong></td>
<td>Sentences stressing that teaching should aim for students to learn science because it provides the correct explanation of the world. The emphasis is on disciplinary facts with vague or no relations to any major context. Scientific theories presented logically but where evidence is lacking (Roberts, 1982, Östman, 1995).</td>
<td>Chemical compounds and how atoms are formed into molecular and ionic compounds through chemical reactions. (Core content, Lgr11, p.191) Pupils have basic knowledge of the structure of materials, their indestructibility and transformation, and other chemical contexts and show this by giving examples and describing them with some use of the concepts, models and theories of chemistry. (Knowledge requirements, Lgr11, p.195)</td>
<td>Use concepts of chemistry, its models and theories to describe and explain chemical relationships in society, nature and in people. (Aim, Lgr11, p.189) Comment: Even though society is included, describing and explaining are stressed and not applying.</td>
</tr>
<tr>
<td><strong>Structure of science</strong></td>
<td>Sentences stressing that the teaching should aim for the students to learn the uniqueness of the natural sciences. Students must understand how knowledge is created, developed and developed, how science differs from other sciences and that the formation of scientific knowledge takes place in a cumulative process. The intellectual process and how science is created in a context is stressed (Roberts, 1998, Östman, 1995). This emphasis includes, for example, when a subject content is explained or proven by means of experiments or demonstration (Östman, 1995). Through knowledge of the nature of science, students’ thinking is developed, e.g. critically review and assess reliability in scientific results (Wickman &amp; Persson, 2009).</td>
<td>In this way, teaching should contribute to pupils developing their critical thinking over their own results, the arguments of others and different sources of information. (Aim, Lgr11, p.188) Usefulness of the theories and models of chemistry, their limitations, validity and variability. (Core content, Lgr11, p.192) Historical and contemporary discoveries in the area of biology and their importance for society, people’s living conditions, and also views of nature and the natural sciences. (Core content, Lgr11, p.170)</td>
<td>Through teaching, pupils should also develop an understanding that statements can be tested and evaluated by using scientific methods. (Aim, Lgr11, p.188) Comment: The sentence stresses how to think and understand how science is created. Pupils should be given opportunities to look for answers by using different types of sources. (Aim, Lgr11, p.188) Comment: Describes how to develop scientific critical thinking.</td>
</tr>
<tr>
<td>Interest</td>
<td>Sentences stressing that the teaching should aim for the students to learn science because it is fun and emotionally engaging. Student's own understanding, experiences, interests and ability to explain nature and the material world are stressed (Roberts, 1982; Wickman &amp; Persson, 2009).</td>
<td>Through teaching, pupils should be given the opportunity to put questions about chemical processes, the properties of matter and its structure based on their own experiences and current events. (Aim, Lgr11, p.188)</td>
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<tr>
<td>Scientific skill development</td>
<td>Sentences stressing that the teaching should aim for the students to learn the scientific way of working, the principles that apply in the exploratory way of working such as testing how different individual methods and processes should be implemented, making hypotheses, generalizing from observations (Östman, 1995). This curriculum emphasis is largely decontextualized and addresses various manipulative skills isolated from each other (Roberts, 1998).</td>
<td>As part of these systematic studies, pupils should be given opportunities, through practical investigative work, to develop skills in the use of both digital tools and other equipment. (Aim, Lgr11, p.188) Models for separation and analysis, such as distillation and identification of substances. (Core content, Lgr11, p.192) In their studies, pupils use equipment in a safe and basically functional way. (Knowledge requirements, Lgr11, p.195)</td>
<td>Formulating simple questions, planning, execution and evaluation. (Core content, Lgr11, p.192) Comment: This is about isolated doing, a specific part of a practical scientific investigation.</td>
</tr>
<tr>
<td>Everyday coping</td>
<td>Sentences stressing that students shall learn to apply scientific knowledge on problems in society and in everyday life. By understanding everyday problems scientifically, they are better prepared to cope with them (Roberts, 1982). Sentences stressing that the teaching should aim for the students to learn science in order to be able to handle practical problems in everyday life. It is not about explaining with the help of everyday life, but about learning to apply interdisciplinary knowledge to deal with everyday life. Includes both the personal level such as applying knowledge in biology to take care of one's own hygiene and a societal level, such as applying knowledge in chemistry to be able to better process iron ore (Roberts, 1982).</td>
<td>Common chemicals in the home and in society, such as cleaning products, cosmetics, paints and fuels, and how they affect health and the environment. (Core content, Lgr11, p.192) Pupils study how some chemicals and chemical processes are used in everyday life and society and describe simple identifiable chemical relationships and give examples of energy transformation and the recycling of materials. (Knowledge requirements, Lgr11, p.196)</td>
<td>Critical examination of sources of information and arguments encountered by pupils in different sources and social discussions related to chemistry, in both digital and other media. (Core content, Lgr11, p.192) Comment: Stressing that scientific knowledge should be applied in everyday life. Particle model to describe and explain the structure, recycling and indestructibility of matter. (Core content, Lgr11, p.191) Comment: Applying chemical knowledge when handling products in the society (waste management) is stressed. It should contribute to students developing their understanding of the importance of biology in society, such as quality of life and health through medicine, and for the protection of the Earth's ecosystems through ecology. (Aim, Lgy11, p.1) Comment: Applying knowledge in biology is stressed. It is not a clear connection to interdisciplinary despite the fact that society is included in the sentence. Pupils can use information in a basically functional way in discussions and create simple texts and other communications with some adaptation to purpose and target group. (Knowledge requirements, Lgr11, p.173) Comment: Stresses that scientific information should be applied in everyday life.</td>
</tr>
<tr>
<td>Science, technology and decisions</td>
<td>As a result, pupils should be given the preconditions to manage practical, ethical and aesthetic situations involving choices that concern energy, the environment, health and society. (Aim, Lgr11)</td>
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<tr>
<td>Sentences that stress that the teaching should aim for the students to learn science in order to be able to make good decisions, alone or together in interdisciplinary contexts such as in matters concerning sustainable development. Unlike the everyday emphasis which is about using science in practical contexts, this curriculum emphasis stresses how scientific knowledge can be weighed together with other perspectives such as economics, ethics, and social factors to solve moral and political problems. Students need to learn to distinguish between values and knowledge as well as science and other scientific disciplines (Roberts, 1982; Östman, 1995, 2014). Take a stand, sustainable development, current societal issues, context are considered as indicative for this emphasis. As well as when theoretical considerations are mixed and evaluated with values. For example, when scientific knowledge has limitations in the practical arena to try to make decisions, e.g. in contexts where the location of a new nuclear power plant is to be discussed (Roberts, 1982).</td>
<td>Pupils can talk about and discuss questions concerning energy, the environment, health and society and differentiate facts from values, and formulate their views with simple reasoning, and also describe some possible consequences. (Knowledge requirements, Lgr11)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comment: Stresses that scientific knowledge is needed when taking a stand in a socio-scientific issue. Categorisation is supported by the discussion about scientific literacy in Marty, Venturine and Almqvist, (2017). Teaching should give pupils opportunities to use and develop knowledge and tools for expressing their own arguments and examining those of others in contexts where knowledge of chemistry is of importance. (Aim, Lgr11, p.188)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current societal issues involving chemistry. (Core content, Lgr11, p.192) Comment: Stressing interdisciplinary perspectives by the content “contexts”. and also by the following sentence “As a result, pupils should be given the preconditions to manage practical, ethical and aesthetic situations involving choices that concern energy, the environment, health and society.” Comment: Stressing interdisciplinary perspectives. In discussions, pupils can put questions and put forward and respond to views and arguments in a way which to some extent takes the discussions forward. (Knowledge requirements, Lgr11, p.195) Comment: Interdisciplinary perspectives are stressed. Pupils can talk about and discuss questions concerning energy, the environment, health and society and differentiate facts from values, and formulate their views with simple reasoning, and also describe some possible consequences. (Knowledge requirements, Lgr11, p.195) Comment: Interdisciplinary perspective and on formulating views are stressed.</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Solid foundation</th>
<th>The school should convey the more enduring knowledge that constitutes the common frame of reference everyone in society needs. (Curriculum, Lgr11, p.7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sentences that stress that the teaching should aim for the students to learn science in order to prepare for future courses, next school year, for your future education (Wickman &amp; Persson, 2009). Students must first learn basic facts and then apply the basic facts (Östman, 1995).</td>
<td>The student can use knowledge from the natural sciences, technical, social sciences, humanities and aesthetic knowledge areas for further study, in social and everyday life. (Curriculum, Lgr11, p.11)</td>
</tr>
<tr>
<td>Comment: Stresses that scientific knowledge is needed when taking a stand in a socio-scientific issue. Categorisation is supported by the discussion about scientific literacy in Marty, Venturine and Almqvist, (2017). Teaching should give pupils opportunities to use and develop knowledge and tools for expressing their own arguments and examining those of others in contexts where knowledge of chemistry is of importance. (Aim, Lgr11, p.188)</td>
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<td>Current societal issues involving chemistry. (Core content, Lgr11, p.192) Comment: Stressing interdisciplinary perspectives. In discussions, pupils can put questions and put forward and respond to views and arguments in a way which to some extent takes the discussions forward. (Knowledge requirements, Lgr11, p.195) Comment: Interdisciplinary perspectives are stressed. Pupils can talk about and discuss questions concerning energy, the environment, health and society and differentiate facts from values, and formulate their views with simple reasoning, and also describe some possible consequences. (Knowledge requirements, Lgr11, p.195) Comment: Interdisciplinary perspective and on formulating views are stressed.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No sentences are found in the syllabuses. Sentences are only found in the curricula.</th>
<th>The purpose of science education – Guidance provided by Swedish science syllabuses</th>
</tr>
</thead>
</table>

NordiNa 18(1), 2022
GENERAL GUIDELINES ON HOW TO CODE

General coding rules
- Code each sentence by using the supportive descriptions in Table 1 and Table 2.
- Each sentence is coded in isolation and based on what it explicitly states.
- A sentence might have several different messages but try as long as possible to place each sentence in only one function/curriculum emphasis based on what it is stressing.
- Each sentence gets the same numerical value independently of how long it is or where in the document it is located.

Exception 1. When a sentence should not be coded in isolation
Sometimes two sentences are clearly related to each other by the use of specific words such as (“in this way”, therefore...). In these cases, the sentences shall not be coded in isolation from each other but instead the meaning of both sentences were used to decide which function and emphasis that is stressed in each sentence.

Example. Pupils should be given opportunities to look for answers by using different types of sources. In this way, teaching should contribute to pupils developing their critical thinking over their own results, the arguments of others and different sources of information.

The second sentence clearly shows that students should learn to seek answers to questions with the help of different sources to develop a critical thinking and therefore the first sentence should be coded as the structure of scientific.

Exception 2. When a sentence should be coded into two functions of education or curriculum emphases
If a sentence clearly stresses two functions or curriculum emphases by, for example, using the word and it can be placed in both categories. For example

Students give an account in basic terms of the meaning of concepts, models, theories and working methods from each of the course’s different areas. This sentence is coded as Correct explanation and Scientific skill development. While for example Knowledge about the structure and indestructibility of matter provides people with the tools to be able to contribute to sustainable development is only coded as Science, technology and decisions.