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Scientific paper

Textbook Sets Through the Perspective of the Orientation of the Intended Chemistry Curriculum for Primary and Secondary Schools

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Abstract

Textbooks have a central role in chemistry education and represent the intended chemistry curriculum at the national level. This paper focuses on analysing the intended chemistry curriculum as represented by the visual representations and the activities for students in the textbook sets in relation to the topics of the Slovenian *National Chemistry Curriculum* both at the primary and secondary school levels. The analysis involved all textbook sets approved by the national representatives for the 2021/2022 school year. The results revealed that in most of the curriculum topics in the analysed Slovenian chemistry textbook sets, the curriculum orientation *structure of the discipline* prevails and the *everyday life orientation* is present for both primary and secondary schools. To improve the relevance of the textbook sets for students, the currently rare presence of *history of chemistry, environmental orientation*, and *technology and industry orientation* and the lack of the use of *socio-scientific orientation* should be overcome. It would be valuable if further studies in textbook sets would also address the intended chemistry curriculum from a more holistic perspective.

Keywords: Intended chemistry curriculum, curriculum orientation, activity for students, visual representation, chemistry textbook set

1. Introduction

1. 1. Textbooks as Representations of the Intended Chemistry Curriculum

The ideas of a curriculum can be manifested by different representations of the curriculum,[1] such as the intended, the implemented, and the attained curriculum.[2] The intended curriculum includes the ideal curriculum, which represents the basic philosophy and rationale of a curriculum, and the formal/written curriculum; the written curriculum represents the intentions as stated in curriculum materials such as textbooks.[2,3] In Slovenia, textbooks for chemistry as a school subject should be in line with the National Curriculum for Chemistry at certain levels of education[4,5] and approved by the Council of Experts of the Republic of Slovenia for General Education[6] or Vocational and Technical Education,[7] thus reflecting the ideal and the formal curriculum for chemistry. Textbooks also have a significant impact on implemented and attained curriculum,[2,3] because they are often used both for teachers' lesson preparation,[8] students' activities during lessons, homework as well as for students' independent learning.[9–11]

1. 2. Curriculum Orientations as a Foundation for the Analysis of the Intended Chemistry Curriculum as Represented by Textbooks

Based on a perception of textbooks as a representation of the intended curriculum,[2] textbooks can be referred to as a reference point to understanding which curriculum orientations are integrated into a particular subject and educational setting and which of them prevails.[12] Six basic orientations of the chemistry curriculum have been identified by Eilks and his colleagues[13] in relation to the previous research work by De Jong.[14] They can be utilised as guiding principles for structuring the curriculum and/or as designated approaches to teaching particular chemistry topics.[13]

The characteristics of each of the curriculum orientations are described below:

- The chemistry curriculum orientation *structure of the discipline* emphasises contemporary theories and facts of chemistry and their interrelationships, on which the structure of the curriculum is built. Social or personal issues and technological applications of chemistry are generally not covered (or only for illustration at the end). As such, it provides an excellent foundation for the later academic study of chemistry[13] and is a suitable approach for a small group of intrinsically motivated[15,16] students who have decided to enrol in this study in the future. The structure of the discipline curriculum could be beneficial for teachers in clarifying the main theories of chemistry and their interrelationships.[13] However, this approach is not in line with modern educational theory, which emphasises the theories of scientific literacy[17] and situated cognition.[18] The importance of students' different motivations, interests, and attitudes in teaching and learning chemistry[19,20] is neglected. However, modern chemistry curricula are moving towards more holistic approaches that integrate the learning of concepts and theories through different contexts from everyday life, technology, and society.[21–24]

- The chemistry curriculum orientation *history of chemistry* emphasises the content of chemistry as it was generated in history and/or its past development.[13] It offers the opportunity to foster an understanding of the nature of science[25,26] in general and the nature of chemistry in particular, which is a central element of scientific literacy and is widely regarded as one of the main goals of science and chemistry education.[27–29] Benefits also include the potential to improve students' interest in and attitudes towards chemistry,[25,30] to promote higher order learning skills, such as critical thinking and problem solving,[31] to improve understanding of the concept of chemistry, and to promote conceptual change.[32] In the latter, care must be taken to ensure that students always know which concepts are part of history and are no longer used today.[13] However, when orientating on the history of chemistry, aspects of the students' everyday life and society are often not sufficiently taken into account.[33]
- The chemistry curriculum orientation *everyday life*, based on the questions of daily life and the chemical knowledge needed to deal with them. Contexts, such as materials used in everyday life, serve as a starting point.[13] In most cases, however, the everyday life orientation is based on Van Berkel's curriculum emphasis[34] on fundamental chemistry, which focuses more on learning theoretical concepts and facts than on the relationship between chemistry and technology and its role in societal issues.[13]
- The *environmental orientation* of the chemistry curriculum focuses on environmental issues, such as acid rain and water pollution and the chemical content behind them. We can assume fundamental chemistry as the curriculum emphasis. However, environmental topics require a more thorough reflection on the interrelation between science, technology, and society.[13]
- In contrast, the *technology and industry orientation* of the chemistry curriculum emphasises chemical technology and developments in industry and the chemical knowledge applied there.[13] The teaching and learning of chemistry that incorporates aspects of the chemical industry thus embraces one of the most important features of modern life and its technological achievements.[35,36] In doing so, it can provide the opportunity for a broader focus that includes the interaction of chemistry and technology in society.[13,35,36]
- *The socio-scientific orientation* of the chemistry curriculum emphasises socio-scientific issues[13] and focuses on authentic social issues.[37] They provide a context for understanding scientific information[38] and are not only the starting point of teaching and learning but also the central content.[22] They are usually controversial in nature and are intended to be important and engaging for students. They require the use of evidence-based arguments on the one hand and moral reasoning or the evaluation of ethical concerns on the other.[38–41] By fostering general education skills in the areas of communication and decision-making, the socio-scientific orientation aims to develop students' scientific literacy and prepare them to become responsible citizens in the future.[13,42] This type of orientation also offers opportunities to achieve the goals of discipline-oriented education for sustainable development by using sustainability-oriented socio-scientific issues.[22,43,44]

The curriculum orientation *everyday life*, *environmental orientation, technology and industry orientation* and *socio-scientific orientation* can be also referred to within context-based curricula,[33] as they all aim to increase students' interest and motivation in chemistry by linking chemical concepts to real-life contexts and, in such a manner make them more relevant for students.[33,45,46]

1. 3. Activities for Students and Visual Representations in Textbooks as an Essential Part of Developing Chemical Understanding

To enhance the teaching and learning of chemistry, significant attention has been devoted to studying students' engagement and research on visualisation, particularly molecular-level representation.[47]

Based on research recommendations, efforts are being made to achieve meaningful student engagement in learning, so-called student-centred learning,[48] through various types of activities for students, from questions in learning materials[49] to practical work in class.[47,50,51] One particularly important kind of practical work for chemistry education is experimental work,[52,53] which can take a variety of forms[54] and often requires students to make connections between the domain of objects and observations and the domain of ideas in order to develop their scientific knowledge.[53] In addition to the acquisition of knowledge, other fundamental goals of experimental work are the development of experimental skills and scientific thinking.[50,53,55]

Learning materials can also contribute to students' engagement in the learning of chemistry with understanding,[49] whereby realistic, conventional, and hybrid visual representations[56] play an important role.[11,57] Visual representations can relate to one of the three levels proposed by Johnstone[58] for representing chemical concepts and processes: macroscopic (observable phenomena), submicroscopic, or particulate (various representations of atomic, molecular and particle structures) and symbolic (mathematical and chemical symbols). Only a few macroscopic observations can be understood without the use of submicroscopic representations or models.[59] Various visualisations are used to help students in linking of the three levels of the concept or process being represented,[60–62] since the interpretation of the macroscopic phenomenon at the particulate level is considered crucial to the creation of accurate mental images or internal representations for corresponding phenomena[63,64] and, as such, is an important component of modern chemistry teaching.[65]

2. The Context and the Purpose of the Study

The use of textbooks has been a habitual means of supporting the effective teaching and learning of school subjects in primary and secondary schools, including the school subject chemistry. To support the quality of textbooks in chemistry education, much attention has been paid to the analysis of various aspects of the textbook,[66,67] for example, the analysis of the learning content,[68–70] the visual representations and their integration,[9,71,72] and the learning activities.[73–75]

However, few textbook analyses focus on the aspect that textbooks convey not only explicit information but also hidden ideas, for example, the purpose of learning chemistry subject matter[13] and, as such, represent intended chemistry curriculum and direct to its orientation.[12] Khaddoor, Al-Amoushab, and Eilks[12] examined 10th-grade chemistry textbooks from seven Arab countries and analysed the intended curriculum as presented by them using the theoretical framework of curriculum emphases[34] and orientations of chemistry curricula.[13] Based on the methodology of Khaddoor et al.,[12] Chen, Chiu and Eilks[76] focused on the representation of the intended curriculum in 10th-grade chemistry textbooks from three Chinese communities. Chen, de Goes, Treagust and Eilks[77] analysed the visual representations of redox reactions in secondary chemistry textbooks from different Chinese communities, focusing on the orientation of the intended curriculum characterised by the contexts proposed for chemistry learning. The same focus was also analysed by authors de Goes, Chen, Nogueira, Fernandez and Eilks,[78] with the difference that they focused on Brazilian chemistry textbooks.

In this paper, we seek to provide new insights into the analysis of the intended chemistry curriculum as represented by textbooks, particularly from the perspective of the included activities for students and visual representations in relation to the curriculum orientations. Among textbook components, activities for students and visual representations are namely recognised in the literature as essential to developing students' deep and coherent understanding of chemistry[47] and have the greatest potential to influence classroom practise.[8] This paper focuses on the activities for students and visual representations in Slovenian chemistry textbooks in relation to the topics of the National Chemistry Curriculum for Primary School,[5] and for General Secondary School – Gymnasium,[4] which represents the current state of the art for Slovenian primary and secondary school chemistry education. Thereby, it is important to note, that chemistry is an obligatory school subject in Slovenian primary schools in eighth and ninth grades (age 13–15 years) and in general secondary schools (age 15–19 years) in the first, second, and third years, whereas fourth-year students can choose chemistry based on their interests.

The following research questions (RQ) were stated:

1st RQ: Which curriculum orientations indicated from the **activities for students** prevail in the analysed Slovenian chemistry textbook sets for *primary school* with respect to the curriculum topics?

2nd RQ: Which curriculum orientations indicated from the **visual representations** prevail in the analysed Slovenian chemistry textbook sets for *primary school* with respect to the curriculum topics?

3rd RQ: Which curriculum orientations indicated from the **activities for students** prevail in the analysed Slovenian chemistry textbook sets for *secondary school* with respect to the curriculum topics?

4th RQ: Which curriculum orientations indicated from the **visual representations** prevail in the analysed Slovenian chemistry textbook sets for *secondary school* with respect to the curriculum topics?

3. Methods

3. 1. Sample

To answer the research questions, we focused on textbook sets, specifically chemistry textbooks for *primary school* (8th and 9th grade; basic compulsory education[79]) approved by the Council of Experts of the Republic of Slovenia for General Education and for *secondary school* (1st, 2nd, and 3rd years; upper secondary general non-compulsory education – gymnasium[79]) approved by the Council of Experts of the Republic of Slovenia for Vocational and Technical Education for the 2021/2022 school year, as well as the accompanying workbooks. Due to the large variety of supplementary materials offered by different publishers, no supplementary materials (e.g., recommendations for teachers) were analysed. Only textbook sets in Slovenian were analysed. Textbook sets dealing only with the elective contents of chemistry were not analysed. If a textbook set is available in i- or e-form as well as in printed form, the printed materials for students were analysed.

Chemistry textbooks for primary and secondary schools in Slovenia must be written on the basis of the objectives of the National Curriculum for Chemistry at certain levels of education,[4,5] which set specific objectives and suggestions for the content for each of the ten topics for primary school and for each of the twelve topics for secondary school (the topics are presented in more detail in section 3.3 Data analysis). Teachers are free to distribute the above curriculum topics in 70 hours in 8^{th} grade and 64 hours in 9^{th} grade in primary school and in 70 hours in 1^{st} year, 70 hours in 2^{nd} year, and 70 hours in 3^{rd} year in secondary school as they see fit. With some publishers, the topics of the National Chemistry Curriculum for Primary School are covered in two different sets of textbooks, namely the 8^{th}-grade textbook set and the 9^{th}-grade textbook set. The same applies to some secondary textbook sets. To overcome this issue, the analysis combined the primary school textbook sets (8^{th} and 9^{th} grade) from the same publisher and the secondary school textbook sets (1^{st}, 2^{nd}, and 3^{rd} year) from the same publisher. Thus, in the analysis of secondary school textbook sets, two textbook sets were excluded whose publishers cover only one of three grades. For a publishing company that offers two

Table 1. The list of the analysed textbook sets for primary school

Publisher	**Textbook set title**	**Author(s)**	**Year of publication (Edition)** ***Textbook/ workbook***	**Number of Pages** ***Textbook/ workbook***	**Grade/ Learner's age**	**Introduction of learning goals at the beginning of chapters** ***Textbook/ workbook***	**Summary of important concepts at the end of chapters** ***Textbook/ workbook***
DZS	Kemija danes 1	Graunar, M., Podlipnik, M., Mirnik, J., Gabrič, A., Glažar, S. A., Slatinek-Žigon, M. (textbook) Graunar, M., Modec. B., Dolenc,D., Gabrič, A., Slatinek Žigon, M. (workbook)	2018 (1st Ed.)/ 2015 (1st Ed.)	160/104	8/13	Yes/No	Yes/No
	Kemija danes 2	Graunar, M., Podlipnik, M., Mirnik, J. (textbook) Dolenc, D., Graunar, M., Modec, B. (workbook)	2016 (1st Ed.)/ 2018 (1st Ed.)	152/96	9/14		
Jutro	Svet kemije 8, Od atoma do molekule	Smrdu, A.	2012 (2nd Ed.)/ 2012 (2nd Ed.)	128/160	8/13	No/Yes	Yes/No
	Svet kemije 9, Od molekule do makromole-kule	Smrdu, A.	2013 (2nd Ed.)/ 2018 (2nd Ed.)	128/152	9/14		
MK	Pogled v kemijo 8	Kornhauser, A., Frazer, M.	2003 (1st Ed.)/ 2004 (1st Ed.)	140/126	8/13	No/No	Yes/No
	Pogled v kemijo 9	Kornhauser, A., Frazer, M.	2005 (1st Ed.)/ 2006 (1st Ed.)	140/115	9/14		
Modrijan	Moja prva kemija	Vrtačnik, M., Wissiak Grm, K. S., Glažar, S. A., Godec, A.	2017 (1st Ed.)/ 2018 (1st Ed.)	239/92	8, 9/13, 14	No/No	Yes/No
Rokus Klett	Peti element 8	Devetak, I., Cvirn Pavlin, T., Jamšek, S.	2017 (1st Ed.)/ 2017 (1st Ed.)	105/71	8/13	Yes/Yes	Yes/No
	Peti element 9	Devetak I., Cvirn Pavlin T., Jamšek S., Vesna, P. Devetak, I.,Cvirn Pavlin, T., Jamšek, S.	2015 (1st Ed.)/ 2012 (1st Ed.)	77/ 79	9/14		
Zavod RS za šolstvo	Kemija 8, i-učbenik	Sajovic, I., Wissiak Grm, K. S., Godec, A., Kralj, B., Smrdu, A., Vrtačnik, M., Glažar, S.	2014	264/0	8/13	Yes	Yes
	Kemija 9, i-učbenik	Jamšek, S., Sajovic, I., Wissiak Grm, K. S.., Godec, A., Boh, B., Vrtačnik, M., Glažar, S.	2013	271/0	9/14		

Table 2. The list of the analysed textbook sets for secondary school

Publisher	**Textbook set title**	**Author(s)**	**Year of publication (Edition)** ***Textbook/ Workbook***	**Number of Pages** ***Textbook/ workbook***	**Grade/ Learner's age**	**Introduction of learning goals at the beginning of chapters** ***Textbook/ workbook***	**Summary of important concepts at the end of chapters** ***Textbook/ workbook***
DZS	Kemija za gimnazije 1	Bukovec, N.	2019 (1st Ed.)/ 2011 (1st Ed.)	144/64	1/15	No/Yes	Yes/No
	Kemija za gimnazije 1	Bukovec, N.	20 (1st Ed.)/ 2012 (1st Ed.)	152/72	2/16	No/Yes	Yes/No
	Kemija za gimnazije 2	Graunar, M., Podlipnik, M., Cvirn Pavlin, T. (textbook) Košmrlj, B., Graunar, M (workbooks).	2019 (1st Ed.)/ 2019 (1st Ed.); 2019 (1st)	248/118;118	3/17	No/No	Yes/No
Jutro	Kemija, Snov in spremembe 1	Smrdu, A.	2015 (2nd Ed.)/ 2015 (2nd Ed.)	144/168	1/15	No/Yes	Yes/No
	Kemija, Snov in spremembe 2	Smrdu, A.	2012 (3rd Ed.)/ 2018 (1st Ed.)	152/168	2/16	No/Yes	Yes/No
	Kemija, Snov in spremembe 3	Smrdu, A.	2016 (2rd Ed.)/ 2012 (1st Ed.); 2016 (1st Ed)	184/96;136	3/17	No/Yes	Yes/No
Modrijan	Atomi in molekule	Godec, A., Leban, I. (textbook) Cebin, N., Klemenčič, B., Prašnikar, M. (workbook)	2019 (1st Ed.)/ 2012 (1st Ed.)	159/124	1/15	Yes/No	Yes/No
	Kemijske reakcije	Godec, A., Leban, I. (textbook) Cebin, N., Klemenčič, B., Prašnikar M. (workbook)	2010 (1st Ed.)/ 2013 (1st Ed.)	174/112	2/16	Yes/No	Yes/No
	Verige in obroči	Tršek, Š., Cerkovnik, J. (textbook) Cebin, N., Klemenčič, B., Prašnikar M. (workbook)	2011 (1st Ed.)/ 2015 (1st Ed.)	199/124	3/17	Yes/No	Yes/No
Zavod RS za šolstvo	Kemija 1, i-učbenik	Smrdu, A., Zmazek, B., Vrtačnik, M., Glažar, S., Godec, A., Ferk Savec, V.	2014 (1st. Ed.)	296/0	1/15	Yes	Yes
	Kemija 2, i-učbenik	Zmazek, B., Smrdu, A., Ferk Savec, V., Glažar, G., Vrtačnik, M.	2014 (1st. Ed.)	245/0	2/16	Yes	Yes
	Kemija 3, i-učbenik	Vrtačnik, M., Zmazek, B., Boh, B.	2014 (1st. Ed.)	335/0	3/17	Yes	Yes

textbooks covering the same curriculum topics for secondary school, the later-released textbook, which also contains a complementary workbook, was chosen.

A list of the textbook sets analysed can be found in Table 1 and Table 2.

3. 2 Instruments

We employed a rubric, based on the criteria for textbook analysis by Devetak and Vorgrinc,[11] for qualitative content analysis of textbook sets in this research. The rubric, adapted by Khaddoor, Al-Amoush and Eilks,[12] as well as by Chen, Chie and Eliks,[76] was used in the analysis and is presented in Table 3.

The detailed criteria for the evaluation of the curriculum orientations category indicated by the activities for students or visual representations, which are the focus of this paper, are presented in Table 4.

To ensure the validity of the rubric, 280 pages of primary school textbook sets and 373 pages of secondary school textbook sets (10% of all textbook set pages analysed) were analysed by both authors to define the main types of activities for students and the main types of visual representations, and to determine the curriculum orientations indicated from the activities for students and visual representations. The textbook set pages analysed were randomly selected from the textbook sets of all publishers. 47 pages each from the primary school textbook sets of the same publisher and 93 pages from the secondary school textbook sets of the same publisher were analysed. To reduce the bias associated with using the rubric to categorise activities for students and visual representations, 95% inter-rater reliability of the rubric was determined through discussion and agreement.

3. 3 Data Analysis

The rubric described in the instruments section was used in the analysis of the general structure, textual ma-

Table 3. The rubric used for analysed textbook sets adapted from Khaddoor, Al-Amoush, and Eilks[12] and Chen, Chie, and Eliks.[76]

<table>
<tr><th>General criteria</th><th>Catego-ry</th><th colspan="2">Subcategories</th></tr>
<tr><td rowspan="3">General structure</td><td rowspan="3">Pages and chapters</td><td colspan="2">Number of pages</td></tr>
<tr><td colspan="2">Number of chapter</td></tr>
<tr><td colspan="2">Length of chapters within a specific curriculum topic</td></tr>
<tr><td rowspan="5">Textual material</td><td rowspan="3">Activities for student</td><td colspan="2">Number of activities for students</td></tr>
<tr><td>Type of activities for students</td><td>Experimental activities (Demonstrations, Individual students' experimentations)
Other practical activities (Tasks for Internet searches; Project work, building molecular structures etc.)
Rating scales related to learning goals
Other tasks for repeating and deepening knowledge</td></tr>
<tr><td>Curriculum orientations indicated from activities for students</td><td>Structure of the discipline orientation
History of chemistry orientation
Everyday life orientation
Environmental orientation
Technology and industry orientation
Socio-scientific orientation</td></tr>
<tr><td rowspan="2">Introduction and summary</td><td colspan="2">Presence of introduction of learning goals at the beginning of chapters</td></tr>
<tr><td colspan="2">Presence of summary of important concepts at the end of chapters</td></tr>
<tr><td rowspan="3">Visual representations</td><td rowspan="3">Visual representations (VRs)</td><td colspan="2">Number of VRs</td></tr>
<tr><td>Type of VRs</td><td>Realistic VRs (Photograph, drawing, video)
Conventional VRs (Graph; Flowchart, diagram, map; Table; Pictogram; Molecular structure --Submicroscopic level or Symbolic level or Submicroscopic & symbolic level; Atomic structure; Other)
Hybrid VRs (Macroscopic level with molecular structure - Macroscopic, submicroscopic & symbolic level or Macroscopic & submicroscopic level or macroscopic & symbolic level; Other)</td></tr>
<tr><td>Curriculum orientations indicated from VRs</td><td>Structure of the discipline orientation
History of chemistry orientation
Everyday life orientation
Environmental orientation
Technology and industry orientation
Socio-scientific orientation</td></tr>
</table>

Table 4. Criteria for the evaluation of the category Curriculum orientations indicated by activities for students or visual representations based on the theoretical framework of Eilks et al.[13] and adapted from Khaddoor, Al-Amoush, and Eilks[12] and Chen, Chie, and Eliks.[76]

<table>
<tr><th>Category</th><th>Subcategory</th><th>Description</th></tr>
<tr><td rowspan="6">Curriculum orientations</td><td>Structure of the discipline orientation</td><td>The analysed part of the textbook set emphasises the contemporary theories and facts of chemistry and their interrelationships</td></tr>
<tr><td>History of chemistry orientation</td><td>The analysed part of the textbook set emphasises the content of chemistry as it was generated in history and/or its past development.</td></tr>
<tr><td>Everyday life orientation</td><td>The analysed part of the textbook set emphasises the questions from everyday life and the chemical knowledge needed to deal with them.</td></tr>
<tr><td>Environmental orientation</td><td>The analysed part of the textbook set emphasises the environmental issues and chemistry content behind them.</td></tr>
<tr><td>Technology and industry orientation</td><td>The analysed part of the textbook set emphasises chemical technology and developments in industry and the chemical knowledge used in these areas today and in the past.</td></tr>
<tr><td>Socio-scientific orientation</td><td>The analysed part of the textbook set emphasises the socio-scientific issue and concerns to prepare students to become responsible citizens in the future.</td></tr>
</table>

terial, and visual representations of the entire sample of chemistry textbook sets presented in Table 1 and Table 2. Textbook sets were analysed individually.

Visual representations that were content-related in a particular area of the textbook set (e.g., submicroscopic representations of modifications of carbon allotropes) and were not specifically separated (e.g., labelled a/b/c) were considered as one visual representation.

The analysed aspects of the textbook sets were categorised with regard to the following curriculum topics of the National Chemistry Curriculum for Primary School:[5] (1) Chemistry is a World of Matter (orig. *Kemija je svet snovi*); (2) Atom and the Periodic System of Elements (orig. *Atom in periodni sistem elementov*); (3) Compounds and Bonding (orig. *Povezovanje delcev/gradnikov*); (4) Chemical Reactions (orig. *Kemijske reakcije);* (5) The Elements in the Periodic Table (orig. *Elementi v periodnem sistemu*); (6) Acids, Bases and Salts (orig. *Kisline, baze in soli*); (7) Hydrocarbons and Polymers (orig. *Družina ogljikovodikov s polimeri*); (8) Organic Compounds Containing Oxygen (orig. *Kisikova družina organskih snovi*); (9) Organic Compounds Containing Nitrogen (orig. *Dušikova družina organskih spojin*), and (10) The Mole (orig. *Množina snovi*) and the following curriculum topics of the National Chemistry Curriculum for Secondary School[4]: (1) Introduction to Safe Experimental Work (orig. *Uvod v varno eksperimentalno delo)*; (2) Building Blocks of Matter (orig. *Delci (gradniki) snovi*); (3) Compounds and Bonding (orig. *Povezovanje delcev (gradnikov)*); (4) Amount of Substance and Chemical Equations as Symbolic Representations (orig. *Simbolni zapisi in množina snovi);* (5) Chemical Reaction as Change of Substance and Energy (orig. *Kemijska reakcija kot snovna in energijska sprememba*); (6) Alkali Metals and Halogens (orig. *Alkalijske kovine in halogeni*); (7) Solutions (orig. *Raztopine*); (8) Chemical Reaction Rates and Equilibrium (orig. *Potek kemijskih reakcij*); (9) The Elements in the Periodic Table (orig. *Elementi v periodnem sistemu*); (10) Properties of Selected Elements and Compounds in Biological Systems and Modern Technologies (orig. *Lastnosti izbranih elementov in spojin bioloških sistemih in sodobnih tehnologijah*); (11) Structure and Nomenclature of Organic Compounds (orig. *Zgradba molekul organskih spojin in njihovo poimenovanje*), and (12) Structure and Properties of Organic Compounds (orig. *Zgradba in lastnosti organskih spojin*).

Finally, the types of activities for students, the types of visual representations and the curriculum orientations indicated by them in each of the topics were counted, and the frequencies for each of the textbook sets were calculated.

To overcome the variability of textbook sets due to the personal style and opinions of the textbook authors,[13] in this article, we use the expression *the analysed Slovenian chemistry textbook sets* and thereby refer to the calculated average of the data obtained from the textbook sets for each of the curriculum topics.

4. Results and Discussion

The results of the analysis of the textbook sets in terms of curriculum orientation indicated by activities for students and visual representations are presented with regard to the research questions. The results of other selected characteristics of activities for students or visual representations from the rubric presented in Table 3 can be found in Appendices 1–4.

4. 1. Curriculum Orientations Indicated from the Activities for Students in Analysed Slovenian Chemistry Textbook Sets for Primary School with Respect to the Curriculum Topics (Related to 1st RQ)

The average number of different curriculum orientations indicated from the activities for students in analysed Slovenian chemistry textbook sets for primary school is shown in Table 5.

Table 5 shows that the largest number of curriculum orientation subcategories with more than 5% of analysed activities for students can be found in the topic 'Hydrocarbons and Polymers' (4 subcategories: *Structure of the discipline orientation*, *Everyday life orientation*, *Environmental orientation*, and *Technology and industry orientation*), followed by 'Chemistry is a World of Matter' (3 subcategories: *Structure of the discipline orientation*, *Everyday life orientation*, and *History of chemistry orientation*) and 'The Elements in the Periodic Table' (3 subcategories: *Structure of the discipline orientation*, *Everyday life orientation*, and *Environmental orientation*). However, in other curriculum topics, only two subcategories prevail, with more than 5% of the activities for students (2 subcategories: *Structure of the discipline orientation* and *Everyday life orientation*).

The analysis of the textbook set revealed that within all the topics of the National Chemistry Curriculum for Primary School, with the exception of the topics 'Organic Compounds Containing Oxygen' ($M = 75.33$ activities, $F_M = 43.93\%$) and 'Organic Compounds Containing Nitrogen' ($M = 15.17$ activities, $F_M = 17.71\%$), more than half of the activities analysed (F_M ranges from 53.81% to 87.69%) indicate curriculum orientation that can be categorised as *Structure of the discipline orientation*. The activities that are categorised in this group particularly prevail in the topic 'Atom and the Periodic System of Elements' ($M = 65.67$ activities, $F_M = 87.69\%$).

The second most frequently used activities within all curriculum topics in the analysed Slovenian chemistry textbook sets indicate a curriculum orientation that can be categorised as *Everyday life orientation* (F_M ranges from 6.87% to 28.17 %). Exceptions are the topics 'Organic Compounds Containing Oxygen' and 'Organic Compounds Containing Nitrogen', for which the *Everyday life orientation* is used most frequently ($M = 97.67$ activities, $F_M = 54.25\%$; $M = 72.67$ activities, $F_M = 81.15\%$, respectively).

In contrast, no or very few activities in analysed Slovenian chemistry textbook sets for primary school within

Table 5: The proportion of curriculum orientations indicated from the activities for students within the particular topics of the analysed Slovenian chemistry textbook sets for primary school.

The topics of the National Chemistry Curriculum for Primary School (8th and 9th Grade)	Curriculum orientations indicated from activities for students													
	Structure of the discipline orientation		History of chemistry orientation		Everyday life orientation		Environmental orientation		Technology and industry orientation		Socio-scientific orientation		M_{SUM}	f (%)
	M[a] Min-max	f_M(%)[b] Min-max	M[a] Min-max	f_M(%)[b] Min-max	M[a] Min-max	f_M(%)[b] Min-max	M[a] Min-max	f_M(%)[b] Min-max	M[a] Min-max	f_M(%)[b] Min-max	M[a] Min-max	f_M(%)[b] Min-max		
Chemistry is a World of Matter	**61.83** 33-118	**66.52** 47.83-82.52	**7.67** 0-16	**7.32** 0.00-12.63	**20.33** 8-44	**22.12** 7.69-31.88	**2.33** 0-9	**2.29** 0.00-6.52	**1.17** 0-3	**1.29** 0.00-2.70	**0.67** 0-4	**0.47** 0.00-2.80	**94.00** 55-143	**100.00**
Atom and the Periodic System of Elements	**65.67** 37-131	**87.69** 77.59-95.62	**3.00** 0-9	**4.25** 0.00-15.52	**3.83** 0-8	**6.87** 0.00-17.02	**0.00** 0-0	**0.00** 0.00-0.00	**0.83** 0-2	**1.18** 0.00-2.50	**0.00** 0-0	**0.00** 0.00-0.00	**73.33** 47-137	**100.00**
Compounds and Bonding	**49.33** 26-78	**78.76** 44.83-93.06	**0.83** 0-4	**1.02** 0.00-4.71	**10.83** 3-32	**19.09** 3.53-55.17	**0.00** 0-0	**0.00** 0.0-0.00	**0.50** 0-3	**1.14** 0.00-6.82	**0.00** 0-0	**0.00** 0.00-0.00	**61.50** 44-85	**100.00**
Chemical Reactions	**51.33** 36-67	**65.55** 46.09-81.33	**1.17** 0-5	**1.34** 0.00-6.02	**24.17** 6-58	**26.96** 12.50-45.31	**2.50** 0-9	**2.25** 0.00-7.03	**2.67** 0-6	**3.91** 0.00-12.50	**0.00** 0-0	**0.00** 0.00-0.00	**81.83** 48-128	**100.00**
The Elements in the Periodic Table	**78.83** 32-142	**53.81** 45.16-63.86	**0.83** 0-2	**0.54** 0.00-1.42	**45.67** 26-63	**34.89** 23.85-47.62	**1.50** 0-5	**1.13** 0.00-3.55	**14.50** 1-34	**9.62** 1.59-14.68	**0.00** 0-0	**0.00** 0.00-0.00	**141.33** 63-240	**100.00**
Acids, Bases and Salts	**92.33** 51-167	**70.45** 60.40-83.61	**0.33** 0-1	**0.26** 0.00-0.92	**34.83** 9-58	**26.51** 14.75-38.93	**2.33** 0-10	**1.38** 0.00-6.25	**1.50** 0-3	**1.40** 0.00-2.75	**0.00** 0-0	**0.00** 0.00-0.00	**131.33** 61-222	**100.00**
Hydrocarbons and Polymers	**104.00** 28-276	**61.41** 51.94-70.77	**2.17** 0-7	**1.56** 0.00-3.85	**35.67** 15-56	**25.20** 14.36-35.65	**12.33** 1-39	**6.29** 1.74-12.40	**7.50** 1-16	**5.54** 0.87-11.54	**0.00** 0-0	**0.00** 0.00-0.00	**161.67** 52-390	**100.00**
Organic Compounds Containing Oxygen	**75.33** 43-173	**43.93** 30.71-57.55	**1.33** 0-8	**0.60** 0.00-3.62	**97.67** 38-197	**54.25** 39.62-68.57	**1.00** 0-4	**0.46** 0.00-1.07	**0.83** 0-2	**0.76** 0.00-1.89	**0.00** 0-0	**0.00** 0.00-0.00	**176.17** 83-374	**100.00**
Organic Compounds Containing Nitrogen	**15.17** 5-25	**17.71** 5.00-28.13	**0.50** 0-1	**0.56** 0.00-1.72	**72.67** 46-112	**81.15** 71.88-94.00	**0.17** 0-1	**0.17** 0.00-1.00	**0.33** 0-1	**0.41** 0.00-1.54	**0.00** 0-0	**0.00** 0.00-0.00	**88.83** 58-138	**100.00**
The Mole	**34.33** 19-50	**70.39** 54.29-94.59	**0.00** 0-0	**0.00** 0.00-0.00	**15.00** 1-37	**28.17** 2.70-45.71	**0.17** 0-1	**0.19** 0.00-1.14	**0.50** 0-2	**1.24** 0.00-4.76	**0.00** 0-0	**0.00** 0.00-0.00	**50.00** 35-88	**100.00**

[a] M was calculated as the average of the number of identified activities in the textbook sets within the category of specific curriculum orientation and within the specific curriculum topics, thereby min and max represent the minimum and maximum number of identified activities in the textbook sets.
[b] f_M(%) represents the proportion of M within each curriculum topic, thereby min and max f_M(%) represent the minimum and maximum number of identified activities between the textbook sets.

all curriculum topics indicate *Socio-scientific orientation* (F_M ranges from 0.00% to 0.47%). In addition, none or less than 5% of the activities within all curriculum topics indicated *History of chemistry orientation* (F_M ranges from 0.00% to 4.25%), with the exception of the topic 'Chemistry is a World of Matter' (M = 7.67 activities, F_M = 7.31%), *Environmental orientation* (F_M ranges from 0.00% to 2.29%) with the exception of the topic 'Hydrocarbons and Polymers' (M = 12.33 activities, F_M = 6.29%) and *Technology and industry orientation* (F_M ranges from 0.76% to 3.91%) with the exception of the topics 'The Elements in the Periodic Table' (M = 14.50 activities, F_M = 9.62%) and 'Hydrocarbons and Polymers' (M = 7.50 activities, F_M = 5.54%).

The findings indicate that most activities for students focus on the content of contemporary chemistry theories and facts and their interrelationships and neglect issues related to the individual, society and technology,[13] as activities indicating chemistry curriculum orientation *structure of the discipline* predominate in most topics of the National Chemistry Curriculum for Primary School. Such activities mainly encourage students who are intrinsically[15] motivated and interested in studying chemistry in the future.[13] However, the analysed Slovenian chemistry textbook sets for primary school also recognise the potential of everyday life as a context for student activities in various curriculum topics that can link chemistry concepts to issues in students' daily lives and improve their interest and motivation in chemistry.[23,24,33] In the topics 'Organic Compounds Containing Oxygen' and 'Organic Compounds Containing Nitrogen', the *everyday life orientation* prevails. In the activities for students on the topic 'Hydrocarbons and Polymers', the connection of chemical concepts with the context of the environment, technology and industry can also be recognised, which indicates the greatest variability in the curriculum orientation of all curriculum topics. However, most other topics in the curriculum do not use the potential of linking to everyday life contexts as mentioned above. Furthermore, in most topics, there are no activities that indicate a *socio-scientific orientation* and focus on socio-scientific issues[13] that not only aim to provide a context for understanding chemistry concepts but also encourage students' development to become responsible citizens in the future.[42] The lack of activities representing *socio-scientific orientation* indicates a possibly missed opportunity to develop students' scientific literacy[17] and to achieve the goals of discipline-oriented education for sustainable development.[22] An unrecognised opportunity to promote the understanding of the nature of science as an important element of scientific literacy[25] in various curriculum topics is also indicated by the absence of activities for students related to the *history of chemistry orientation*.

4. 2. Curriculum Orientations Indicated from the Visual Representations in Analysed Slovenian Chemistry Textbook Sets for Primary School with Respect to the Curriculum Topics (Related to the 2nd RQ)

The average number of different curriculum orientations indicated from the visual representations for students in the analysed Slovenian chemistry textbook sets in primary school is presented in Table 6.

From Table 6, it can be derived that the largest number of subcategories of curriculum orientation, with more than 5% of the analysed visual representations for students, can be recognised within the topic 'Chemistry is a World of Matter' (4 subcategories: *Structure of the discipline orientation*, *Everyday life orientation*, *Technology and industry orientation*, and *History of chemistry orientation*) and 'Hydrocarbons and Polymers' (4 subcategories: *Structure of the discipline orientation*, *Everyday life orientation*, *Technology and industry orientation*, and *Environmental orientation*), followed by 'Atom and the Periodic Table' (3 subcategories: *Structure of the discipline orientation*, *Everyday life orientation*, and *History of chemistry orientation*), 'Chemical Reactions' (3 subcategories: *Structure of the discipline orientation*, *Everyday life orientation*, and *Technology and industry orientation*) and 'The Elements in the Periodic Table' (*Structure of the discipline orientation*, *Everyday life orientation*, and *Technology and industry orientation*). However, in the other half of the curriculum topics, only two subcategories prevail, with more than 5% of the activities for students (2 subcategories: *Structure of the discipline orientation* and *Everyday life orientation*).

The analysis of the textbook set revealed that the visual representations for students within half of the topics of the National Chemistry Curriculum for Primary School ('Chemistry is a World of Matter', 'Atom and the Periodic System of Elements', 'Compounds and Bonding', 'Acids, Bases and Salts', 'Hydrocarbons and Polymers') indicate curriculum orientation, which can most often be categorised as *Structure of the discipline orientation.* Whereby the analysed representations represent approximately half or more of all visual representations within a particular curriculum topic (M = 38.67 VRs, F_M = 47.40%; M = 39.50 VRs, F_M = 68.13%; M = 36.00 VRs, F_M = 68.60%; M = 42.17 VRs, F_M = 57.34%, M = 74.83 VRs, F_M = 55.49%, respectively). *Structure of the discipline orientation* represents the second most frequently analysed curriculum orientation, indicated by visual representations within the topics 'Organic Compounds Containing Oxygen' (68.17 VRs; 42.39%), 'Organic Compounds Containing Nitrogen' (M = 14.00 VRs; F_M = 15.64%) and 'The Mole' (M = 8.67 VRs; F_M =15.64%). For the latter three topics, *everyday life orientation* is the most commonly used curriculum orientation, as indicated by the visual representations analysed, and represents approximately half or more of all visual representations within a given curriculum topic (M = 91.00 VRs, F_M = 55.06%; M = 59.17 VRs, F_M = 77.88%; M = 14.00 VRs, F_M = 60.95%, respectively). Within the other curriculum topics, the subcategory *Everyday life orientation* represents the second most frequent subcategory of curriculum orientations (F_M ranges from 29.74% to 45.23 %) with the exception of the topics 'Chemical Reactions' and 'The Elements in the Periodic Table', for which the proportion of the subcategory *Everyday life orientation* (M = 24.00 VRs, F_M = 42.06%; M = 42.50 VRs, F_M = 45.23%, respectively) is about the same as the proportion of the subcategory *Structure of the discipline orientation* (M = 25.00 VRs, F_M = 45.68%; M = 40.50 VRs, F_M = 41.64%, respectively).

In contrast, no or very few activities in analysed Slovenian chemistry textbook sets in primary school within all curriculum topics indicate *socio-scientific orientation* (F_M ranges from 0.00% to 0.27%). In addition, none or less than 5% of the activities within all curriculum topics indicates *history of chemistry orientation* (F_M ranges from 0.33% to 3.72%), with the exception of the topics 'Chemistry is a World of Matter' (M = 6.83 VRs, F_M=9.09%) and 'Atom and the Periodic System of Elements' (M = 8.67 VRs, F_M = 14.34%), *environmental orientation* (F_M range

Table 6: The proportion of curriculum orientations indicated from the visual representations (VRs) for students within the particular topics of the analysed Slovenian chemistry textbook sets for primary school

The topics of the National Chemistry Curriculum for Primary School (8th and 9th Grade)	Curriculum orientations indicated from visual representations (VRs) for students													
	Structure of the discipline orientation		History of chemistry orientation		Everyday life orientation		Environmental orientation		Technology and industry orientation		Socio-scientific orientation		M_{SUM}	f (%)
	M[a] Min-max	f_M(%)[b] Min-max	M[a] Min-max	f_M(%)[b] Min-max	M[a] Min-max	f_M(%)[b] Min-max	M[a] Min-max	f_M(%)[b] Min-max	M[a] Min-max	f_M(%)[b] Min-max	M[a] Min-max	f_M(%)[b] Min-max		
Chemistry is a World of Matter	**38.67** 8-61	**47.40** 21.62-63.54	**6.83** 1-11	**9.09** 1.16-12.86	**25.83** 14-36	**35.83** 20.00-62.16	**1.17** 0-2	**1.84** 0.00-5.41	**5.17** 0-20	**5.84** 0.00-21.51	**0.00** 0-0	**0.00** 0.00-0.00	**77.67** 37-96	**100.00**
Atom and the Periodic System of Elements	**39.50** 13-71	**68.13** 44.83-81.82	**8.67** 4-21	**14.34** 11.84-20.79	**7.17** 1-14	**14.31** 2.78-37.93	**0.17** 0-1	**0.22** 0.00-1.32	**1.83** 0-4	**3.00** 0.00-5.17	**0.00** 0-0	**0.00** 0.00-0.00	**57.33** 29-101	**100.00**
Compounds and Bonding	**36.00** 17-55	**68.60** 49.02-82.09	**0.17** 0-1	**0.33** 0.00-1.96	**15.67** 5-25	**29.74** 14.93-49.02	**0.00** 0-0	**0.00** 0.00-0.00	**0.83** 0-3	**1.33** 0.00-5.00	**0.00** 0-0	**0.00** 0.00-0.00	**52.67** 22-67	**100.00**
Chemical Reactions	**25.00** 14-32	**45.68** 30.77-68.09	**1.67** 1-3	**3.13** 1.54-6.82	**24.00** 8-36	**42.06** 17.02-55.38	**1.33** 0-4	**2.21** 0.00-6.15	**4.17** 0-11	**6.93** 0.00-13.92	**0.00** 0-0	**0.00** 0.00-0.00	**56.17** 44-79	**100.00**
The Elements in the Periodic Table	**40.50** 22-51	**41.64** 34.38-49.49	**1.33** 0-4	**1.50** 0.00-4.26	**42.50** 31-65	**45.23** 30.28-57.81	**0.83** 0-2	**0.93** 0.00-1.83	**10.67** 3-22	**10.70** 4.55-20.18	**0.00** 0-0	**0.00** 0.00-0.00	**95.83** 64-121	**100.00**
Acids, Bases and Salts	**42.17** 35-52	**57.34** 47.37-74.47	**0.50** 0-3	**0.69** 0.00-4.17	**30.33** 12-41	**39.19** 25.53-46.05	**1.67** 0-5	**2.09** 0.00-6.58	**0.67** 0-4	**0.67** 0.00-4.04	**0.00** 0-0	**0.00** 0.00-0.00	**75.33** 47-99	**100.00**
Hydrocarbons and Polymers	**74.83** 23-160	**55.49** 32.86-65.71	**2.33** 0-6	**1.92** 0.00-4.29	**31.83** 14-46	**27.46** 18.78-41.43	**9.17** 4-18	**7.89** 3.05-12.86	**7.50** 3-17	**6.97** 2.14-14.52	**0.17** 0-1	**0.27** 0.00-1.61	**125.83** 62-245	**100.00**
Organic Compounds Containing Oxygen	**68.17** 45-95	**42.39** 34.84-50.88	**1.00** 0-3	**0.67** 0.00-1.96	**91.00** 55-155	**55.06** 43.14-63.52	**1.17** 0-3	**0.73** 0.00-2.26	**1.83** 0-8	**1.15** 0.00-5.23	**0.00** 0-0	**0.00** 0.00-0.00	**163.17** 114-244	**100.00**
Organic Compounds Containing Nitrogen	**14.00** 0-32	**15.64** 0.00-29.36	**2.83** 0-6	**3.72** 0.00-9.38	**59.17** 48-75	**77.88** 60.55-96.00	**0.00** 0-3	**0.00** 0.00-0.00	**2.50** 0-9	**2.76** 0.00-8.26	**0.00** 0-0	**0.00** 0.00-0.00	**78.50** 50-109	**100.00**
The Mole	**8.67** 2-16	**32.88** 16.67-47.06	**0.83** 0-1	**3.25** 0.00-5.00	**14.00** 10-18	**60.95** 44.12-83.33	**0.33** 0-2	**0.98** 0.00-5.88	**0.50** 0-1	**1.93** 0.00-4.55	**0.00** 0-0	**0.00** 0.00-0.00	**24.33** 12-34	**100.00**

[a] M was calculated as the average of the number of identified visual representations in the textbook sets within the category of specific curriculum orientation and within the specific curriculum topics, thereby min and max represent the minimum and maximum number of identified visual representations in the textbook sets.
[b] f_M(%) represents the proportion of M within each curriculum topic, thereby min and max f_M(%) represent the minimum and maximum number of identified visual representations between the textbook sets.

from 0.00% to 2.21%), with exception of the topic 'Hydrocarbons and Polymers' (M = 9.17 VRs, F_M = 7.89%) and *technology and industry orientation* (F_M range from 0.67% to 3.00%), with the exception of the topics 'Chemistry is a World of Matter' (M = 5.17 VRs, F_M = 5.84%), 'Chemical Reactions' (M = 4.17 VRs, F_M = 6.93%), 'The Elements in the Periodic Table' (M = 10.67 VRs, F_M = 10.70%) and 'Hydrocarbons and Polymers' (M = 7.50 VRs, F_M = 6.97%).

The results revealed that in analysed Slovenian chemistry textbook sets for primary school, half of the topics in the National Chemistry Curriculum for Primary School are dominated by visual representations that present chemical theories and their interconnections to the students without integrating them into different contexts or indicating the structure of the discipline chemistry curriculum orientation.[13] The prevalence of this type of visual representations neglects the importance of the different motivations, interests and attitudes of students in chemistry.[19,20] In the other half of the curriculum topics (topics 'Chemical Reactions', 'The Elements in the Periodic Table', 'Organic Compounds Containing Oxygen', 'Organic Compounds Containing Nitrogen' and 'The Mole'), the visual representations focus almost as often or even more often on the challenges of everyday life and the chemical knowledge that is important for dealing with them. In this way, they attempt to increase the students' interest and motivation for chemistry[23,24] and indicate the everyday life chemistry curriculum orientation.

In most cases, however, the focus is on learning theoretical concepts and facts rather than the relationships between chemistry, technology, and society.[13] The greatest diversity of visual representations in terms of curriculum orientation was found in the topic 'Hydrocarbons and Polymers', in which visual representations also indicate an environmental curriculum orientation and a technology and industry curriculum orientation, and in the topic 'Chemistry is a World of Matter', in which visual representations also indicate a history of chemistry curriculum orientation and a technology and industry curriculum orientation. Furthermore, in the topics 'Chemical Reactions', and 'The Elements in the Periodic Table', further visual representations can be recognised that indicate technology and industry curriculum orientation. In contrast, in most other curriculum topics, the potential of linking chemistry concepts to real contexts related to the environment, technology and industry, or to the history of chemistry, is rarely used. As with the activities for students, there are no visual representations in most topics that focus on mostly controversial, engaging social issues that are important to students and that promote general educational skills in terms of communication and decision-making and prepare students to take on a responsible role as contributing members of society in the future.[39–42] The absence of visual representations representing socio-scientific curriculum orientation indicates a missed opportunity to promote students' scientific literacy[13,42] and provide them with an education geared towards sustainable development.[22,43,44]

4. 3. Curriculum Orientations Indicated from the Activities for Students in Analysed Slovenian Chemistry Textbook Sets for Secondary School With Respect to the Curriculum Topics (Related to the 3rd RQ)

The average number of different curriculum orientations indicated from the activities for students in analysed Slovenian chemistry textbook sets for secondary school is shown in Table 7.

Table 7 shows that the largest number of subcategories for curriculum orientation, with more than 5% of the analysed activities for students, can be found in the topic 'Properties of Selected Elements and Compounds in Biological Systems and Modern Technologies' (3 subcategories: *Structure of the discipline orientation*, *Everyday life orientation*, and *Technology and industry orientation*). In contrast, for the topics 'Building Blocks of Matter Structure' and 'Structure and Nomenclature of Organic Compounds', there is only one subcategory (*Structure of the discipline orientation*) with more than 5% of the activities for students.

The analysis of the secondary textbook sets revealed that within all topics of the National Chemistry Curriculum for Secondary School, except for the topic 'Properties of Selected Elements and Compounds in Biological Systems and Modern Technologies' (M = 12.75 activities, F_M = 31.98%), more than two thirds of the activities analysed (F_M ranges from 67.10% to 94.66%) indicate a curriculum orientation that can be categorised as *Structure of the discipline orientation*. The activities that can be categorised in this group are particularly dominant in the topics 'Building blocks of matter' (M = 111.75 activities, F_M = 94.66%) and 'Structure and nomenclature of organic compounds' (M = 134.50 activities, F_M = 94.21%). The second most frequently used activities within all curriculum topics in the typical Slovenian secondary chemistry textbook set indicate a curriculum orientation that can be classified as *Everyday life orientation* (F_M ranges from 2.66% to 28.65%). An exception is the topic 'Organic Compounds Containing Oxygen', in which the *Everyday life* orientation is used most frequently (M = 15.75 activities, F_M = 43.26%).

In contrast, there were no activities in the typical Slovenian chemistry textbooks within all secondary school curriculum topics that indicated *Socio-scientific orientation* (M = 0.00 activities, F_M = 0.00%). In addition, none or less than 5 % of the activities within all secondary school curriculum topics indicated *Technology and industry orientation* (F_M ranges from 0.00% to 2.74%), with the exception of the topic 'Properties of Selected Elements and Compounds in Biological Systems and Modern Technologies' (M = 8.50 activities, F_M = 22.75%), *History of chemistry orientation* (F_M ranges from 0.00% to 2.64%) and *Environmental orientation* (F_M ranges from 0.00% to 3.36%).

The results show that most topics in the National Chemistry Curriculum for Secondary School emphasise the core content of modern chemical theories and facts in the activities for students, while aspects related to the individual, society and technology are neglected.[13] A notable exception is the topic 'Properties of Selected Elements and Compounds in Biological Systems and Modern Technologies', whose name inherently signals an integration of real-life contexts in order to engage students with different interests and attitudes in the teaching and learning of chemistry.[19,20] The lack of use of different contexts in most secondary curriculum topics, and in particular the absence of socio-scientific issues,[13] points to the possibility of improving activities to develop both chemical knowledge and general education skills for active engagement in social issues in the future.[13,42]

Table 7: The proportion of curriculum orientations indicated from the activities for students within the particular topics of the analysed Slovenian chemistry textbook sets for secondary school

The topics of the National Chemistry Curriculum for Secondary School (1st, 2nd and 3th Year)	Curriculum orientations indicated from activities for students													
	Structure of the discipline orientation		History of chemistry orientation		Everyday life orientation		Environmental orientation		Technology and industry orientation		Socio-scientific orientation		M_{SUM}	f (%)
	M[a] Min-max	f_M(%)[b] Min-max	M[a] Min-max	f_M(%)[b] Min-max	M[a] Min-max	f_M(%)[b] Min-max	M[a] Min-max	f_M(%)[b] Min-max	M[a] Min-max	f_M(%)[b] Min-max	M[a] Min-max	f_M(%)[b] Min-max		
Safe Experimental Work	**33.00** 20-48	**76.48** 62.86-95.45	**0.25** 0-1	**0.40** 0.00-1.59	**8.75** 2-14	**21.69** 4.55-31.43	**0.25** 0-1	**0.71** 0.00-2.86	**0.25** 0-1	**0.71** 0.00-2.86	**0.00** 0-0	**0.00** 0.00-0.00	**42.50** 8-63	**100.00**
Building Blocks of Matter	**111.75** 76-149	**94.66** 90.63-99.07	**2.00** 0-4	**1.92** 0.00-3.61	**3.25** 0-8	**2.66** 0.00-6.25	**0.00** 0-0	**0.00** 0.00-0.00	**0.75** 0-2	**0.77** 0.00-2.41	**0.00** 0-0	**0.00** 0.00-0.00	**117.75** 83-153	**100.00**
Compounds and Bonding	**136.25** 96-166	**81.17** 73.85-89.08	**0.50** 0-1	**0.34** 0.00-0.77	**28.75** 19-40	**17.72** 10.92-23.67	**0.00** 0-0	**0.00** 0.00-0.00	**1.00** 0-4	**0.77** 0.00-3.08	**0.00** 0-0	**0.00** 0.00-0.00	**166.50** 130-193	**100.00**
Amount of Substance and Chemical Equations as Symbolic Representa-tions	**93.75** 59-135	**77.03** 71.81-80.91	**1.00** 0-2	**0.90** 0.00-2.53	**27.50** 18-50	**21.72** 18.42-26.60	**0.25** 0-1	**0.22** 0.00-0.88	**0.25** 0-1	**0.13** 0.00-0.53	**0.00** 0-0	**0.00** 0.00-0.00	**122.75** 79-188	**100.00**
Chemical Reaction as Change of Substance and Energy	**50.00** 31-69	**75.83** 65.88-88.46	**0.00** 0-0	**0.00** 0.00-0.00	**12.00** 3-21	**18.45** 5.66-31.91	**1.75** 0-6	**3.36** 0.00-11.32	**2.00** 0-8	**2.35** 0.00-9.41	**0.00** 0-0	**0.00** 0.00-0.00	**65.75** 47-85	**100.00**
Alkali Metals and Halogens	**49.00** 37-71	**85.13** 69.81-92.59	**0.25** 0-1	**0.47** 0.00-1.89	**6.75** 4-12	**12.05** 7.41-22.64	**0.25** 0-1	**0.47** 0.00-1.89	**1.25** 0-3	**1.87** 0.00-3.77	**0.00** 0-0	**0.00** 0.00-0.00	**57.50** 42-81	**100.00**
Solutions	**92.00** 67-131	**70.83** 54.92-83.62	**0.00** 0-0	**0.00** 0.00-0.00	**35.75** 19-54	**28.65** 15.82-44.26	**0.75** 0-2	**0.52** 0.00-1.27	**0.00** 0-0	**0.00** 0.00-0.00	**0.00** 0-0	**0.00** 0.00-0.00	**128.50** 116-158	**100.00**
Chemical Reaction Rates and Equilibrium	**401.75** 334-505	**89.64** 83.71-93.77	**0.50** 0-1	**0.11** 0.00-0.25	**37.75** 16-56	**8.30** 3.99-12.28	**3.00** 0-9	**0.75** 0.00-2.26	**5.25** 3-7	**1.21** 0.70-1.75	**0.00** 0-0	**0.00** 0.00-0.00	**448.25** 399-567	**100.00**
The Elements in the Periodic Table	**54.75** 31-89	**83.94** 75.61-96.55	**0.50** 0-2	**1.22** 0.00-4.88	**7.75** 1-17	**11.19** 1.72-15.45	**0.50** 0-1	**0.91** 0.00-1.92	**1.75** 0-4	**2.74** 0.00-7.32	**0.00** 0-0	**0.00** 0.00-0.00	**65.25** 41-110	**100.00**
Properties of Selected Elements and Compounds in Biological Systems and Modern Technologies	**12.75** 4-24	**31.98** 12.12-48.00	**0.00** 0-0	**0.00** 0.00-0.00	**15.75** 14-19	**43.26** 30.00-57.58	**0.75** 0-2	**2.02** 0.00-6.06	**8.50** 4-10	**22.75** 12.12-30.30	**0.00** 0-0	**0.00** 0.00-0.00	**37.75** 33-50	**100.00**
Structure and Nomenclature of Organic Compounds	**134.50** 70-226	**94.21** 89.74-97.84	**2.50** 0-6	**2.64** 0.00-7.69	**4.25** 2-5	**3.15** 2.16-4.31	**0.00** 0-0	**0.00** 0.00-0.00	**0.00** 0-0	**0.00** 0.00-0.00	**0.00** 0-0	**0.00** 0.00-0.00	**141.25** 78-231	**100.00**
Structure and Properties of Organic Compounds	**384.75** 290-537	**67.10** 57.20-80.15	**4.00** 0-10	**0.79** 0.00-2.08	**156.75** 121-187	**28.53** 18.06-36.88	**11.25** 9-13	**2.06** 1.34-2.56	**8.00** 1-13	**1.52** 0.15-2.56	**0.00** 0-0	**0.00** 0.00-0.00	**564.75** 481-670	**100.00**

[a] M was calculated as the average of the number of identified activities in the textbook sets within the category of specific curriculum orientation and within the specific curriculum topics, thereby min and max represent the minimum and maximum number of identified activities in the textbook sets.

[b] f_M(%) represents the proportion of M within each curriculum topic, thereby min and max f_M(%) represent the minimum and maximum number of identified activities between the textbook sets.

4. 4. Curriculum Orientations Indicated from the Visual Representations in Analysed Slovenian Chemistry Textbook Sets for Secondary School with Respect to the Curriculum Topics (Related to 4th RQ)

The average number of different curriculum orientations indicated from the visual representations for students in the analysed Slovenian chemistry textbook sets for secondary school is given in Table 8.

From Table 8, it can be derived that the largest number of subcategories of curriculum orientation, with more than 5% of the analysed visual representations for students, can be recognised within the topic 'Chemical Reaction as Change of Substance and Energy' (4 subcategories: *Structure of the discipline orientation*, *Everyday life orientation*, *Environmental orientation*, and *Technology and industry orientation*), followed by 'Safe Experimental Work', 'Building Blocks of Matter', 'Amount of Substance and Chemical Equations as Symbolic Representations' (3 subcategories: *Structure of the discipline orientation*, *Everyday life orientation*, and *History of chemistry orientation*) and 'Solutions' and 'Properties of Selected Elements and Compounds in Biological Systems and Modern Technologies' (3 subcategories: *Structure of the discipline orientation*, *Everyday life orientation*, and *Technology and industry orientation*). However, in other six curriculum topics for secondary school, only two subcategories prevail with more than 5% of the activities for students (2 subcategories: *Structure of the discipline orientation* and *Everyday life orientation*).

The analysis of the secondary textbook sets in relation to the visual representations revealed that the curriculum orientation *Structure of the discipline* predominates in the topics of the National Chemistry Curriculum for Secondary School (F_m ranges from 52.95% to 91.87%), with the exception of the topics 'Solutions' (M = 20.25 activities, F_M = 44.89%), in which about the same number of visual representations indicate *Everyday life orientation* (M = 18.75 activities, F_M = 44.12%), and 'Properties of Selected Elements and Compounds in Biological Systems and Modern Technologies' (M = 7.00 activities, F_M = 22.19%), in which the most common curriculum orientation is *Everyday life orientation* (M = 18.75 activities, F_M = 55.34%).

Everyday life orientation is the second most common curriculum orientation, as can be found from the analysed visual representations (F_M ranges from 7.14% to 44.12%), with the exception of the already discussed topic 'Properties of Selected Elements and Compounds in Biological Systems and Modern Technologies' (M = 18.75 activities, F_M = 55.34%) and the topic 'Building Blocks of Matter' (M = 4.00 activities, FM = 8.86%), with the second most common orientation being *History of chemistry orientation* (M = 7.50 activities, FM = 13.16%).

In contrast, there were no visual representations in the typical Slovenian chemistry textbooks within all secondary school curriculum topics that indicated *Socio-scientific orientation* (M = 0.00 activities, FM = 0.00%). In addition, none or less than 5 % of visual representations within all secondary school curriculum topics indicate *History of chemistry orientation* (F_M ranges from 0.99% to 4.23%), with the exception of 'Safe Experimental Work' (M = 1.75 activities, F_M = 5.09%), 'Building Blocks of Matter' (M = 7.50 activities, F_M = 13.16%), and 'Amount of Substance and Chemical Equations as Symbolic Representations' (M = 3.75 activities, F_M = 9.15%), *Environmental orientation* (F_M ranges from 0.00% to 2.06%), except for the topic 'Chemical Reaction as Change of Substance and Energy' (M = 3.50 activities, FM = 10.59%) and *Technology and industry orientation* (F_M ranges from 0.00% to 3.76%), with the exception of the topics 'Chemical Reaction as Change of Substance and Energy' (M = 2.50 activities, F_M = 6.48%), 'Solutions' (M = 3.25 activities, F_M = 7.74%) and 'Properties of Selected Elements and Compounds in Biological Systems and Modern Technologies' (M = 7.25 activities, F_M = 20.38%).

The results indicate that in most topics of the National Chemistry Curriculum for Secondary School, similar to the activities for students, the visual representations mainly focus on chemical theories, facts, and their interrelationships.[13] In this case, too, the exception is the topic Properties of Selected Elements and Compounds in Biological Systems and Modern Technologies', and additionally the topic 'Solutions'. However, the visual representations in analysed Slovenian chemistry textbook sets for secondary school show a greater variety of contexts in some topics, which relate not only to questions of everyday life and the chemical knowledge required for this, but in some topics also to contexts related to history, the environment and technology, but also there without pronounced socio-scientific issues.[13,45]

It can be derived from Tables 4 to 8 that the number of different curriculum orientations indicated by both the activities and visual representations varies between the textbook sets, with the exception of the activities and visual representations that indicate socio-scientific curriculum orientation. This suggests that primary and secondary textbook set authors recognise the potential of each curriculum topic for the use of activities and visual representations that indicate different curriculum orientations in different ways. This confirms the influence of textbook set authors' personal views on the textbook sets as representations of the intended curriculum for chemistry.[12]

5. Conclusions

Textbook sets are one of the most important teaching aids that support the effective teaching and learning of chemistry in primary and secondary schools. They contain various components, with activities for students and visual representations having the greatest potential to influence

Table 8: The proportion of curriculum orientations indicated from the visual representations (VRs) for students within the particular topics of the analysed Slovenian chemistry textbook sets for secondary school

The topics of the National Chemistry Curriculum for Secondary School (1st, 2nd and 3th Year)	**Curriculum orientations indicated from visual representations (VRs) for students**													
	Structure of the discipline orientation		**History of chemistry orientation**		**Everyday life orientation**		**Environmental orientation**		**Technology and industry orientation**		**Socio-scientific orientation**		**M_{SUM}**	**f (%)**
	M[a] Min-max	**f_M(%)[b] Min-max**	**M[a] Min-max**	**f_M(%)[b] Min-max**	**M[a] Min-max**	**f_M(%)[b] Min-max**	**M[a] Min-max**	**f_M(%)[b] Min-max**	**M[a] Min-max**	**f_M(%)[b] Min-max**	**M[a] Min-max**	**f_M(%)[b] Min-max**		
Safe Experimental Work	**24.00** 17-36	**68.63** 50.00-85.00	**1.75** 1-3	**5.09** 2.70-8.82	**9.75** 2-14	**25.61** 10.00-41.18	**0.25** 0-1	**0.68** 0.00-2.70	**0.00** 0-0	**0.00** 0.00-0.00	**0.00** 0-0	**0.00** 0.00-0.00	**35.75** 20-52	**100.00**
Building Blocks of Matter	**42.75** 23-64	**75.47** 52.17-86.49	**7.50** 1-12	**13.16** 3.57-26.09	**4.00** 3-6	**8.86** 4.05-14.29	**0.00** 0-0	**0.00** 0.00-0.00	**1.25** 0-4	**2.51** 0.00-8.70	**0.00** 0-0	**0.00** 0.00-0.00	**55.50** 28-74	**100.00**
Compounds and Bonding	**93.50** 62-130	**66.54** 55.36-79.47	**3.75** 1-8	**2.44** 0.89-4.19	**40.25** 26-53	**30.63** 17.22-42.86	**0.00** 0-0	**0.00** 0.00-0.00	**0.50** 0-1	**0.39** 0.00-0.89	**0.00** 0-0	**0.00** 0.00-0.00	**138.00** 98-191	**100.00**
Amount of Substance and Chemical Equations as Symbolic Representa-tions	**25.75** 15-38	**61.99** 50.00-78.38	**3.75** 2-5	**9.15** 5.41-11.90	**11.00** 6-16	**27.97** 16.22-38.10	**0.00** 0-0	**0.00** 0.00-0.00	**0.50** 0-2	**0.89** 0.00-3.57	**0.00** 0-0	**0.00** 0.00-0.00	**41.00** 29-56	**100.00**
Chemical Reaction as Change of Substance and Energy	**19.00** 12-27	**52.95** 37.50-75.00	**0.75** 0-2	**2.26** 0.00-6.25	**10.00** 2-16	**27.74** 5.56-39.02	**3.50** 0-9	**10.59** 0.00-28.13	**2.50** 0-6	**6.48** 0.00-14.63	**0.00** 0-0	**0.00** 0.00-0.00	**35.75** 32-41	**100.00**
Alkali Metals and Halogens	**16.25** 8-21	**59.06** 44.44-77.78	**1.00** 1-1	**3.94** 2.50-5.56	**9.00** 3-16	**33.28** 11.11-50.00	**0.75** 0-3	**1.88** 0.00-7.50	**0.50** 0-2	**1.85** 0.00-7.41	**0.00** 0-0	**0.00** 0.00-0.00	**27.50** 18-40	**100.00**
Solutions	**20.25** 4-37	**44.89** 9.52-67.27	**0.50** 0-2	**1.19** 0.00-4.76	**18.75** 15-23	**44.12** 27.27-54.76	**1.00** 0-3	**2.06** 0.00-5.45	**3.25** 0-13	**7.74** 0.00-30.95	**0.00** 0-0	**0.00** 0.00-0.00	**43.75** 36-55	**100.00**
Chemical Reaction Rates and Equilibrium	**123.25** 93-134	**70.11** 59.62-77.78	**5.75** 3-9	**3.25** 1.75-4.62	**38.00** 27-48	**21.78** 15.79-28.85	**2.00** 0-5	**1.23** 0.00-3.21	**6.25** 5-7	**3.62** 2.56-4.49	**0.00** 0-0	**0.00** 0.00-0.00	**175.25** 156-195	**100.00**
The Elements in the Periodic Table	**29.5** 19-42	**66.80** 51.79-82.35	**2.00** 0-4	**4.23** 0.00-7.14	**11.5** 6-23	**25.22** 14.04-41.07	**0.00** 0-0	**0.00** 0.00-0.00	**1.75** 0-5	**3.76** 0.00-8.77	**0.00** 0-0	**0.00** 0.00-0.00	**44.75** 32-57	**100.00**
Properties of Selected Elements and Compounds in Biological Systems and Modern Technologies	**7.00** 4-11	**22.19** 9.52-39.29	**0.75** 0-2	**2.08** 0.00-4.76	**18.75** 13-23	**55.34** 46.43-65.63	**0.00** 0-0	**0.00** 0.00-0.00	**7.25** 3-13	**20.38** 10.71-30.95	**0.00** 0-0	**0.00** 0.00-0.00	**33.75** 28-42	**100.00**
Structure and Nomenclature of Organic Compounds	**163.00** 80-277	**91.87** 85.11-94.63	**1.75** 0-4	**0.99** 0.00-2.68	**11.00** 4-18	**7.14** 2.68-14.89	**0.00** 0-0	**0.00** 0.00-0.00	**0.00** 0-0	**0.00** 0.00-0.00	**0.00** 0-0	**0.00** 0.00-0.00	**175.75** 94-297	**100.00**
Structure and Properties of Organic Compounds	**428.00** 234-674	**62.71** 47.27-76.24	**7.00** 4-12	**1.06** 0.64-1.41	**210.75** 152-275	**33.40** 21.04-46.46	**10.25** 7-17	**1.75** 0.79-3.43	**6.75** 3-10	**1.09** 0.57-2.02	**0.00** 0-0	**0.00** 0.00-0.00	**662.75** 495-884	**100.00**

[a] M was calculated as the average of the number of identified visual representations in the textbook sets within the category of specific curriculum orientation and within the specific curriculum topics, thereby min and max represent the minimum and maximum number of identified visual representations in the textbook sets.

[b] f_M(%) represents the proportion of M within each curriculum topic, thereby min and max f_M(%) represent the minimum and maximum number of identified visual representations between the textbook sets.

teaching practice[8] and being essential to the development of students' knowledge of chemistry.[47] As representations of the intended chemistry curriculum[2,3] textbook sets can direct to the orientation of the chemistry curriculum.[12] Eilks and his colleagues[13] have defined six basic orientations of the chemistry curriculum, which are guiding principles for structuring the whole curriculum and/or approaches for teaching a particular chemistry subject matter.

This paper presents an analysis of the intended chemistry curriculum in Slovenia, as represented by chemistry textbook sets in primary school (8th and 9th grade) and secondary school (1st, 2nd, and 3rd year), from the perspective of curriculum orientations indicated by the activities for students and visual representations related to the topics of the National Chemistry Curriculum.[4,5]

Regarding the activities for students and visual representations in the analysed Slovenian chemistry textbook sets for primary school, the results show the dominance of the chemistry curriculum orientation *structure of the discipline* and, especially for organic chemistry topics, also the *everyday life* orientation. The greatest diversity of activities for students and visual representations in primary school related to curriculum orientation could be found in the topic 'Hydrocarbons and Polymers', where the analysed part of the textbook set also indicates *environmental orientation* and *technology and industry orientation*. The greatest diversity among the visual representations could be found in the topic 'Chemistry is a World of Matter' in which the visual representations also refer to the *history of chemistry* and the *technology and industry orientation*. The other curriculum orientations in terms of activities for students and visual representations are less common in most other topics of the National Chemistry Curriculum for Secondary School, with the lack of *socio-scientific orientation* being particularly noticeable.

With regard to the activities for students and visual representations in the analysed Slovenian chemistry textbook sets for secondary school, the results indicate that the chemistry curriculum orientation *structure of the discipline* prevails, and that the *everyday life* orientation is present. The everyday life orientation is particularly present in the topic 'Properties of Selected Elements and Compounds in Biological Systems and Modern Technologies'. In the mentioned topic, it is also possible to find the greatest variety of activities for secondary school students in terms of curriculum orientation, with the analysed part of the textbook set also indicating the *technology and industry orientation*. The greatest diversity among the visual representations could be found in the topic 'Chemical Reaction as Change of Substance and Energy' in which the visual representations also refer to the *environmental orientation* and the *technology and industry orientation*. As with the analysis at the primary school level, the other curriculum orientations in terms of activities for students and visual representations are relatively rare in most of the other topics of the National Chemistry Curriculum for Secondary School.

The findings that the activities for students and the visual representations focus more on learning theoretical concepts and facts than on the interaction of chemistry with technology and society,[13] and the lack of use of *socio-scientific orientation* indicates that the intended chemistry curriculum for primary and secondary school, as represented by the activities and visual representations in the textbook sets, still has much potential to approach modern chemistry curricula that incorporate more holistic approaches and integrate the learning of concepts and theories through different contexts from everyday life, technology and society.[21-24] They also point to a possibly missed opportunity to develop students' scientific literacy[13,17,42] and to achieve the goals of discipline-oriented education for sustainable development,[22,43,44] as well as to the possibility of further improving the intended chemistry curriculum for primary and secondary school as presented in the textbooks.

The results of the presented study are particularly important because Slovenia has just started to reform the curricula of all subjects in primary and secondary school, including chemistry. After the implementation of the curriculum reform, the existing textbooks will be revised, and it would be beneficial for the students if the results of the study could be taken into account.

It is important to note that in our study chosen segments of the textbook sets (the activities for students and visual representations) seem to be a fundamental part of the textbook sets, but we are aware that their ability to fully reveal curriculum orientation is limited.[78] Therefore, it would be valuable to consider future research opportunities to analyse the textbook sets also from the perspective of further textbook segments to provide a more holistic insight.

As various curriculum orientations with their characteristics contribute to varying degrees to the relevance of learning and teaching chemistry subject matter,[33,80,81] it would be valuable to analyse the intended chemistry curriculum for primary and secondary school from the perspective of relevance in order to make chemistry education for young people more relevant in terms of individual as well as societal and vocational dimensions in the future.

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Povzetek

Učbeniki imajo osrednjo vlogo pri poučevanju in učenju kemije in predstavljajo predvideni učni načrt za kemijo na nacionalni ravni. Prispevek se osredinja na analizo predvidenega učnega načrta za kemijo, kot ga predstavljajo vizualne reprezentacije in aktivnosti za učence oz. dijake v učbeniških setih v povezavi z vsebinskimi sklopi nacionalnega učnega načrta za kemijo za osnovno in srednjo šolo. Analiza, ki je vključevala s strani nacionalnih predstavnikov potrjene učbeniške komplete za šolsko leto 2021/2022, temelji na šestih osnovnih usmeritvah kemijskega učnega načrta, ki jih je opredelil Eilks s sodelavci. Rezultati so pokazali, da v analiziranih slovenskih učbeniških kompletih za kemijo tako za osnovno kot za srednjo šolo pri večini vsebinskih sklopov prevladuje usmerjenost v strukturo discipline, prisotna pa je tudi usmerjenost v vsakdanje življenje. Za namen izboljšanja relevantnosti učbeniških kompletov za učence je potrebno preseči trenutno redko prisotnost usmerjenosti v zgodovino kemije, okolje, tehnologijo in industrijo ter socio-naravoslovni kontekst, npr. z vključevanjem večje interakcije kemije, tehnologije in družbe. Dragoceno bi bilo, če bi nadaljnje raziskave naslavljale predvideni učni načrt za kemijo tudi z bolj celostnega vidika.