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Research Article

Conceptual mapping of geography textbook content on the example of the desert biome

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Keywords

*Geography textbook,
textbook analysis,
desert,
conceptual mapping*

Abstract

The aim of this study is to identify the key terms used by textbook authors when presenting desert biomes and, subsequently, to visualise the relationships between them using a conceptual map. To achieve this objective, we assessed geography textbooks using conceptual maps, which can be used to conceptualise this topic. The method used is innovative in textbook research and can be used to present results in a visual form with added value. A total of eleven university students created conceptual maps for each of the five analysed textbooks, and this was followed by a synthesis and comparison of the created maps. The effectiveness and clarity of the analysed content is one of the advantages of this visual form of analysis. The data were analysed qualitatively and quantitatively. The results show that the presentation of desert biomes in the textbooks we analysed is somewhat superficial, as the authors do not strive to interconnect concepts from different areas, and their conceptual maps lack higher hierarchy levels. Therefore, textbook authors should opt for a different conceptual approach to explanatory texts instead of the traditional coverage of the individual components of geographical environments.

Highlights:

- The structures of Czech geographical textbooks are based on outmoded content-based approaches
- The text in textbooks shows little potential for the development of systems thinking
- In some cases, textbooks contain stereotyping cases of curriculum presentation
- Text don't connect concepts from different fields, their concept maps have a low hierarchical level



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1. INTRODUCTION

The concept of geography education has changed significantly over the last few years. A departure from presentation of factographic syllabi (such as Marada et al., 2017; NCGE, 2012, etc.) is becoming apparent in the curricular documents of some countries, and greater emphasis is placed on relationships and context in space and time, as well as the mutual interaction between the natural and socio-economic spheres. Furthermore, curriculum content focuses on key (geographic) concepts (Maude, 2020). Instead of acquiring the knowledge of specific factographic data, students are expected to understand and interpret these data correctly and seek the causes and consequences of natural and socio-economic phenomena and processes. These changes in the approach to geographic education are necessarily reflected in the didactic aids used in geography learning and teaching and, by extension, in geography textbooks, as these are the most commonly used didactic aids, which users see as key prerequisites for teaching geography (Esteves, 2019).

Although research on geography textbooks is currently rather sparse, one of its major drawbacks is its non-innovative framing (Kidman & Papadimitriou, 2012; Bagoly-Simó, 2019). Some authors point to the insufficient theoretical volume of this area of research. The non-innovative use of textbook research is another problem (Bagoly-Simó, 2018; Bock, 2018). The current specialised research of textbooks places emphasis, among other aspects, on the analysis of textbooks in relation to the objectives of the specific study, with the authors examining the historical or socio-cultural context of the selected subject matter (Jennings, 2006; Sidorov, 2009; Cain, 2015; and others). The problematic implementation of the research findings and conclusions in textbook revisions is a further major shortcoming of specialised didactic research (compare with Lee & Catling, 2017). Textbook research currently does not reflect new pedagogical or psychological directions in education (such as constructivism, conceptual change issues, system thinking, etc. —see, for example: Vosniadou, 2013; Reinfried et al., 2015, Cox, 2018). The introduction of major innovations in textbook production cannot be expected if the concept of textbook research remains rigid (compare Kučerová, Kučera, & Novotná, 2018).

Pedagogical constructivism is one of the trends that has gained in strength in geographic learning and teaching over the last few years (Driver, 198; Lane, 2008; Reinfried et al., 2015). Unlike the traditional concept, this method of teaching places emphasis on students' activity in the educational process, the presentation of specific curricula, and the relationships between key concepts in curriculum content (Lane, Carter, & Bourke, 2019). Constructivism in tuition strives to build on students' previous knowledge and experience and to confront students with the latest, albeit didactically restructured, scientific knowledge (Fosnot, 2013). Studies have shown that teaching based on constructivism is more effective, as students are able to master curriculum content more effectively and permanently, successfully apply the knowledge gained, and seek relationships and connections between individual curriculum topics. Moreover, students enjoy this type of learning much more (Pine, Messer, & St. John, 2001; Reinfried, 2006). Unfortunately, specialised research has so far failed to address whether textbooks apply constructivist approaches to tuition. Over the last few years, attention has been paid mainly to the assessment of actual tuition through observation and video studies, including questionnaires or didactic tests (e.g., Reinfried et al., 2015; Lorenz, Roth, & Priese, 2017). Geography education can be viewed as a single, coherent subject, including didactic aids (comp. Bagoly-Simó, 2013; Lorenz, Roth, & Priese, 2017; Trahorsch & Bláha, 2019). This is why the presentation of topics in textbooks in connection with the current psychodidactic aspects of geography education, not only with regard to the current historical and sociocultural context of textbook content, also needs to be studied.

Research using conceptual mapping is an effective approach to the examination of the relationships between phenomena. This method is very often used to identify the structure of the knowledge of a specific respondent through research projects based on the theoretical grounds referred to above (e.g. pedagogical constructivism; Novak & Gowin, 1984). Typically, the aim of the research is to identify children's conception of the relevant phenomenon; in other words, how the individual student perceives, understands, and interprets the relevant

phenomenon (Wandersee, 1990; Wehry et al., 2012); in geographical education, this method is used as a tool to measure or develop systems thinking (Cox, Elen, & Steegen, 2019). Systems thinking defined Arnold and Wade (2015, p. 675) as a set of synergetic, analytical skills used to improve the capability of identifying and understanding systems, predicting their behavior, and devising modifications to them in order to produce desired effects. The conceptual mapping method commonly supplements an interview with the respondents, helping to identify the relationships and connections between key terms used by the individual to define and specify the studied phenomenon and visualise these relationships in a mental model (Doulík & Škoda, 2008). This method is applied in the analysis of textbook content rather sporadically (compare Soyibo, 1995; Wu, Lee, & Lai, 2004). The application of conceptual mapping in the research on or assessment of geography textbooks can provide rather different outcomes compared to the conventional content analysis of texts (for example, the connections between the individual components of the geographical environment).

Therefore, we propose the following research question: *What concepts do textbook authors choose for the presentation of phenomena, and which relationships and connections do these concepts reveal?* The desert biome is the phenomenon we will use in order to answer this research question. This phenomenon was selected due to (1) the potential complexity of presentation of the desert biome in textbooks; (2) the background provided in previous studies examining children's conception of the desert and the consequent options for comparing textbook content with students' actual conception of deserts; (3) the integration of this topic in the curriculum content in different parts of the world.

The aims of this study are to analyse the content of chapters dealing with the topic of deserts in geography textbooks for lower secondary education and to identify the structure of and relationships between key terms selected by textbook authors for the presentation of the relevant topic. The achievement of this objective may provide information on how textbook authors reflect on the current state of knowledge in specialised didactic research, and whether they place sufficient emphasis on relationships and connections between key terms in their textbooks.

2. THEORETICAL BACKGROUND AND CURRENT STATE OF KNOWLEDGE

2.1 Theoretical basis for conceptual mapping of the content of geography textbooks

This study is based on the theoretical framework of the curriculum (including textbooks) in systems theory in (geography) education and the theory of conceptual change. These theories support the relevance of the application of the conceptual mapping method to the analysis of textbooks and, especially, to the educational and scientific consequences of the data obtained.

The study uses the term 'key term' for first-order concepts (such as groundwater, temperatures, camels etc.). 'Key term' is used for this group of concepts to avoid confusion with other categories (see below). Conversely, the term 'key concept' (or 'big idea') normally refers to (abstract) second-order concepts (such as place / space, scale, system etc.). The study does not explicitly work with these terms, but based on our results, it is possible to deduce some outputs in relation to key concepts (e.g., the presentation of the environment). Nevertheless, it is necessary to define these key concepts, as their clear definition provides a framework for modern geographical education. Fögele (2016) defines key concepts as structured and interconnected ideas, theories, and explanatory models that emerge from the structure of a subject to describe basic subject-specific processes and phenomena. Key concepts should be at the top of the hierarchy, abstract, sufficiently general, and applicable to the various thematic areas of geography (Maude, 2020). They should be applied in the creation and revision of curricula, and, therefore, textbooks. Otherwise, conventional and rigid curricula may emerge, and science may become separated from primary education. Taylor (2008) and Fögele (2016) provide an overview of key geographical concepts by various authors. The Czech curriculum, on which this study is based, defines six key concepts

(Marada et al., 2017), place and region, location, development, interactions, scale, and distribution, as well as their interrelationships.

In the literature, there are several references to the concept of powerful knowledge. The author of this concept is M. Young (2009), a sociologist of education. The term refers to field-specific knowledge, which is the basis for understanding the content of a field, which students do not acquire at home, at work, or at school, but through a degree of acquired experience (Roberts, 2014). This knowledge equips students with orientation in their field, helping them to design cognitive procedures, consider logical alternatives, etc. (Maude, 2019). In Young's study, he refers to the work of Vygotsky (1962), who described the notion of the development of spontaneous and scientific concepts. Although both Young and Vygotsky address different concepts in education, Vygotsky focuses on the development of mental models, while Young focuses on how knowledge of the curriculum can be theorized (Roberts, 2014). Both approaches are applied in this study, as the conceptual mapping of textbook content determines, to some extent, the structure of concepts in the curriculum (textbook), while, on the other hand, it has the potential to reveal the structure in which the presented concepts are learned by students.

In addition to the issues of key concepts in geography and powerful knowledge, conceptual mapping is based on the theory of systems thinking. It refers to the cognitive ability to think in context, to construct causal diagrams, and to relate individual concepts (Cox, Elen, & Steegen, 2019). Because conceptual mapping places different concepts in context and creates a coherent whole from them, it supports systems thinking (Hmelo-Silver et al., 2017). The systems concept of geographical thinking is also reflected in other concepts, such as system competence (Rempfler & Uphues, 2012) or geospatial thinking (Favier & van der Schee, 2014). The presentation of concepts through a conceptual map can provide information on which system is chosen for the presentation of a given curriculum. Moreover, the results of conceptual mapping can, to some extent, measure the level of support for systems thinking, as conceptual maps are very often used in the development of this cognitive skill (Cox, Elen, & Steegen, 2019). It should be added that since systems thinking supports the understanding of basic geographical concepts, even the appropriate presentation of the results of conceptual mapping can identify a certain system of strengths and weaknesses in the presentation of a curriculum. Cox's study (2018), which primarily focuses on the concepts involved in teaching geography and the teaching methods used, including the application of conceptual mapping, shows that one of the factors in the development of systems thinking is curriculum content.

In contrast to the above theories, the theory of conceptual change is focused directly on the student. This theory emphasises the gradual transformation of children's concepts and misconceptions in the desired direction, i.e., it eliminates misconceptions and brings thinking closer to current scientific knowledge (Vosniadou, 2013). Conceptual mapping very often actively used in research, as it has the potential to identify the structures of partial terms (Doulík & Škoda, 2008; Strommen, 1995; Rey-Goyeneche & Alexander, 2021). However, even textbooks can cause misconceptions due to the stereotyping of content, excessive generalisation (Testa, Leccia, & Puddu, 2014), professional errors in the text (King, 2010), and graphical representations (Trahorsch, 2022). The conceptual mapping of textbook content can thus identify potential sources of misconceptions and ground teaching preparation based on constructivism and internal cognitive conflict, which eliminates the emergence, development, and number of misconceptions based on empirical evidence (Limón, 2001; Smith, diSessa, & Roschelle, 1993). Textbooks that use constructivism as a source of knowledge can encourage students to develop more accurate ideas about geographical phenomena, although it is necessary for the content of textbooks to be in line with current trends in geographical education and scientific knowledge.

2.2 Current state of knowledge, with a focus on misconceptions about and textbook research on deserts

As the conceptual mapping method is applied to the desert biome in this study, which is based on the theoretical background to the development of children's conceptions and misconceptions, it is essential to describe the current state of knowledge in the research on the perception of deserts by lower-secondary-school students and the research on biomes in textbooks. Lower-secondary-school pupils understand deserts as vast, dry, and hot areas covered by sand (Dove, 1999; Schubert, 2014; Schubert & Wrenger, 2016). Students do not take into account different top layers in deserts (stone, gravel) or various types of deserts in different climatic zones (such as polar deserts). They mostly locate deserts in Africa (Schubert, 2014). They see wind as the main geomorphological factor, as it shifts sand and contributes to the creation of deserts, along with ocean activity (Schubert & Wrenger, 2016). Camels and cactuses are seen as the typical biota of deserts, although students are unable to place them in the correct region (Trahorsch & Trhlíková, 2021). Desertification as a key problem associated with deserts is linked to natural and anthropogenic factors; pupils overestimate natural factors over anthropogenic ones (Schubert, 2015). Although the authors of the studies conducted so far associate these outcomes with, for example, the content of didactic aids (e.g., photographs in textbooks), these misconceptions are primarily linked to students' excessive generalisation of their own experience and information from the media (see also Rye, 2013).

The research on biomes in textbooks is sporadic in focus. Behnke (2016) examined the design of textbooks in relation to student learning, using the example of biomes. Textbook design (the arrangement of text, visuals, and other elements of textbook content) appears to be a crucial factor for effective learning. Trahorsch and Trhlíková (2021) analysed the content of geography textbooks with a focus on biomes, monitoring which topics were presented by textbook authors and which were not. According to this analysis, the authors of geography textbooks primarily focus on physical and geographical phenomena, while socio-geographical phenomena are presented sporadically. Furthermore, traditional interpretations of the curriculum predominate. Maude and Caldis (2019) evaluated textbooks in relation to powerful knowledge and the proposed structure of a biomass lesson; the authors state that to a relatively minor extent, the textbooks support the systemic concept of geography and are considerably reserved about the presentation of powerful knowledge. Other, non-specific, studies point out that the physical-geographical content of textbooks in particular may be the cause of pupils' perceptions. For example, King (2010) draws attention to a number of simplistic claims regarding the geological composition of particular regions and the extraction of minerals; furthermore, Bozkurt (2019) draws attention to the proliferation of a simplistic concept of climate change, which also affects the desert. Thus, in general, textbooks are a possible source of misconceptions and, currently, do not allow a fundamental increase in the effectiveness of students' learning.

3. METHODOLOGY

This study can be classified under the analysis of curriculum content, specifically under textbook analysis (Okeeffe, 2013). The study aims to identify the key terms selected by textbook authors for the presentation of the desert biome and subsequently use conceptual maps to visualise the relationships between them. The outcomes are interpreted through a comparison between the conceptual maps of individual textbooks and a synthesis of the resulting data.

3.1 Research sample

The research sample consisted of five Czech geography textbooks for lower secondary schools (for students aged approximately 11–12 years—see table 1), which are in print at the

time of writing. All the textbooks were approved by the Czech Ministry of Education, Youth and Sports for use in lower secondary schools, as this is one of the main prerequisites for their use in Czech schools. The criteria for selecting the textbooks were, in addition to the award of the Clause, topicality (the age of the textbook at the time of evaluation up to 10 years from publication), and their active use in the teaching of geography in the Czech Republic. Another criterion was the thematic focus of the textbook on physical geography, as the topic of deserts is taught in the Czech curriculum within this unit. Each of the evaluated textbooks had to be published by a different publisher, and, therefore, the authors of each title had to be different. Attention was only paid to the respective chapters dealing with the desert biome in the selected textbooks.

Table 1. Overview of the analysed textbooks and specification of the analysed chapters

Textbook identification in the text	Publisher	Textbook quotation and chapters	Number of words in chapter	Number of sentences in chapter
Textbook A	Fraus	Červený et al. (2013, pp. 60–61)	379	40
Textbook B	Nakladatelství ČGS	Červinka & Tampír (2015, pp. 78–79)	351	38
Textbook C	Nová škola	Chalupa & Cimala (2017, p. 101)	155	15
Textbook D	Prodos	Demek & Voženílek (2019, p. 93)	109	10
Textbook E	Státní pedagogické nakladatelství	Demek et al. (2019, pp. 76–77)	411	33

A total of 11 assessors were asked to create a conceptual map for each of the five textbooks for the analysis of their text. The assessors were pre-service geography teachers, who were trained according to the guidelines listed in the next section of this chapter. This choice can be explained by the specialized qualifications of assessors in their field, including the future use of textbooks.

3.2 Principles and process of text analysis

The method of conceptual mapping was used for the analysis of textbooks. Conceptual mapping is a method involving identification of the structure of knowledge in selected individuals (Novak & Gowin, 1984). The concepts (terms), mostly indicated in a conceptual map in a bubble or a rectangle, are the basic elements of conceptual maps; these concepts are connected by a link that shows the relationship between them (Rebich & Gautier, 2005; West et al., 2000). Conceptual maps can also be seen as instruments for analysing the content of communication (compare with Freeman & Jessup, 2004). This method can be used to identify the structure of key terms in text communication. The content-analysis method does not focus on specific individuals (research subjects); instead, it is used to study different communications, such as text or its analysis through didactic aids (Sidorov, 2009; Bagoly-Simó, 2013; Kučerová, Kučera, & Novotná, 2018). Conceptual mapping can therefore be applied with success to the analysis of the use of terms in textbooks or in selected parts of textbooks. Unlike conventional text analysis, conceptual mapping can identify effectively and then visualise key terms from textbooks that structure their chapters and make them comprehensible. Moreover, the outcomes of textbook analysis using conceptual mapping can inform us as to how the authorities in a given field, i.e., textbook authors, view the relevant topics (Lee & Catling, 2017).

The process of conceptual-map creation presented below was based on the analysis of the selected texts and any visuals they included, as well as the structuring of the texts into subchapters and paragraphs (see below). In the analysis of the selected texts, which was the basis of the conceptual map creation, assessors strived to identify the key terms (first-order concepts; see chapter 2.1) important for structuring of the chapter and understanding the meaning of the message conveyed in the presentation text. Attention was also paid to

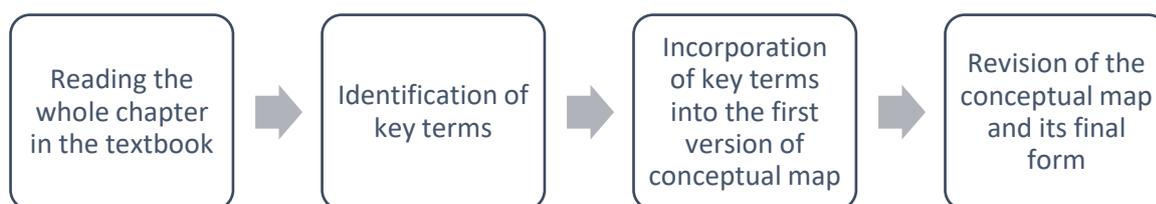
relationships in which the key terms were arranged by the authors of individual textbooks. The analysis did not take into account any study tasks, marginals, additional text, or titles provided for visuals, as these parts of textbooks are not essential for structuring of the main message conveyed in chapters; the content of the visuals was analysed in a quantitative analysis, because the methodology used in this study encourages this approach (e.g. D'Antoni, Zipp and Olson, 2009). The assessors were instructed to be as specific as possible when creating the conceptual maps, i.e., to state specific terms (such as specific examples of phenomena and processes) they identified directly in the text when creating their maps.

When creating concept maps, the evaluators were invited to focus on the content of the textbooks rather than their own ideas. The aim was ensure that the conceptual maps from individual assessors were as similar as possible in order to facilitate the interpretation of the data obtained and specify the curriculum structure; in addition, this measure was also applied to increase the objectiveness of the analysis.

Prior to beginning their analysis, the assessors were informed about the process of analysis, its meaning, and the theoretical background of conceptual mapping. Each of the assessors received the key principles of analysis listed in this part of the study before analysing the texts and creating the conceptual maps for each of the five textbooks. Each of the assessors created their conceptual map independently, without cooperating with other assessors. The inclusion of a relatively high number of assessors was intended to reduce subjective nature of conceptual-map creation from the relevant textbook and increase the objectiveness of the analysis; for example, assessors may have interpreted the text in the textbooks differently from their colleagues and, thus, they may have identified different key terms or different relationships between them.

Text analysis and conceptual-map creation consisted of several stages. In the first stage, the assessors read entire chapters and gained insights into the structure of the text (primary analysis of the chapter text). In the second stage, the conceptual maps were gradually created, i.e., the key terms and the relationships between them were identified and then plotted in the conceptual map. The third stage involved potential revisions of the created conceptual maps or their clarification (a revision analysis of the chapter text). The aim of this procedure was to eliminate the creation of accidental connections between the key terms and to prompt self-reflection of the analysis from the assessors (see figure 1).

Figure 1. Diagram of the analysis of presentation text in textbooks



3.3 Processing the obtained data

After the conceptual maps were received from all 11 assessors, synthesis of the conceptual maps for each of the textbooks followed. This synthesis was performed by two cooperating assessors, who discussed every connection and verified it in the textbooks. Their activity resulted in the creation of five aggregated conceptual maps (one conceptual map for each of the textbooks). These aggregations are net structures of conceptual maps from the point of view of conceptual-map typology, as this type has the potential to visualise the relationships between key terms much more clearly than other types of conceptual map, such as chain-structure or spoken-structure conceptual maps (Kinchin & Hay, 2000).

The analysis of the aggregated conceptual maps was conducted on qualitative and quantitative levels. In addition to the specialised geographic aspects of concepts in conceptual maps, the qualitative analysis also studied identical and differing elements of the conceptual maps across the analysed textbooks. The aims of the qualitative analysis were to identify the prevailing presentation of desert biomes in textbooks and to identify specific positive and negative aspects of the presentation of this topic.

The methodology for the quantitative analysis was adopted and modified from the studies by D'Antoni, Zipp, and Olson (2009) and West et al. (2002). When analysing conceptual maps, these authors assigned scores for the following criteria: concept link (two points), cross link (ten points), hierarchy (five points), example (one point), invalid or erroneous content (zero points), image (five points), and colour (five points). As this study focused on the analysis of the text in textbooks rather than conceptual maps devised by students, not all of the categories listed above could be applied (for example, colours could not be evaluated, as they were not apparent from the presentation text).

The following scoring system was therefore applied:

- Concept links: Two points were assigned for each link between identified concepts;
- Crosslinks: Ten points were assigned for each link demonstrating relationships between various geographical components (such as the relationship between the climatic zone and economic activities in the region);
- Hierarchies: Five points were assigned for each level of the conceptual map;
- Examples: One point was assigned for each example provided;
- Visuals: Five points were assigned for each concept that included a visual.

This scoring system is based on the level of elaboration of the concepts within a specific phenomenon, which, in this case, was deserts. The final number, indicating the overall score of a specific conceptual map, was the outcome of the data processed in this manner. A higher score indicated a higher level of elaboration of the monitored phenomenon and, therefore, a higher level of complexity of the relevant conceptual map. The quantitative analysis only supplemented the qualitative analysis of conceptual maps and was used to compare the level of complexity of the presentation of deserts across individual textbooks; the combination of both approaches can help to obtain more valid research outcomes (Freeman & Jessup, 2004).

4. RESULTS AND THEIR INTERPRETATION

4.1 Results of qualitative analysis of conceptual maps

Figures 2–6 show synthesised conceptual maps from the analysed geography textbooks and Table 2 provides an overview of the key results arising from the analysis presented in this part of the chapter. The figures show that the authors whose textbooks we studied mainly opt for the content-based approach to the presentation of the curriculum when presenting the desert biome (focusing on individual components of the geographical environment). While this structure does not interfere with the traditional arrangement of the text, it may complicate students' understanding of the relationships and connections between individual components of the geographical environment to a certain extent. Geography therefore loses its complexity, which is one of its key characteristics.

The analysis showed that the issues associated with deserts are not presented in the textbooks with their causes and consequences. In other words, a problem-based approach is absent from the texts; the chapter content focuses primarily on the description of the current state and, sometimes, on its assessment, but the pursuit of problems in the relevant field (such as desertification) is never the focus.

Figure 4: Conceptual map of the topic of desert in Textbook C (Nová škola)

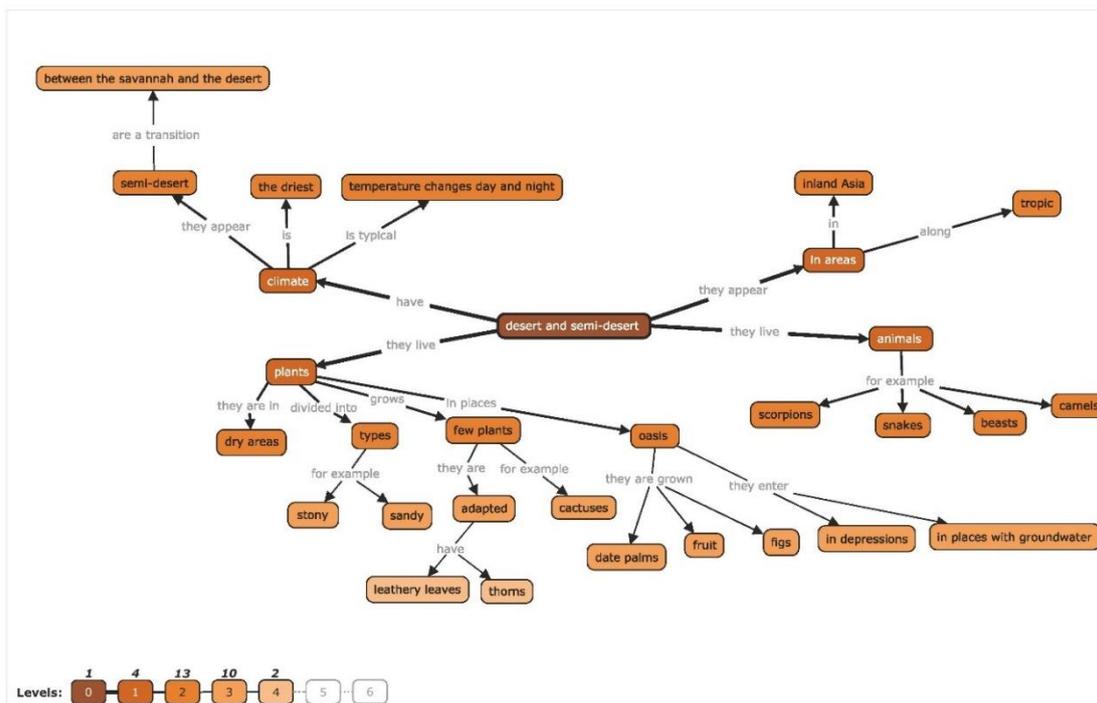


Figure 5: Conceptual map of the topic of desert in Textbook D (Prodos)

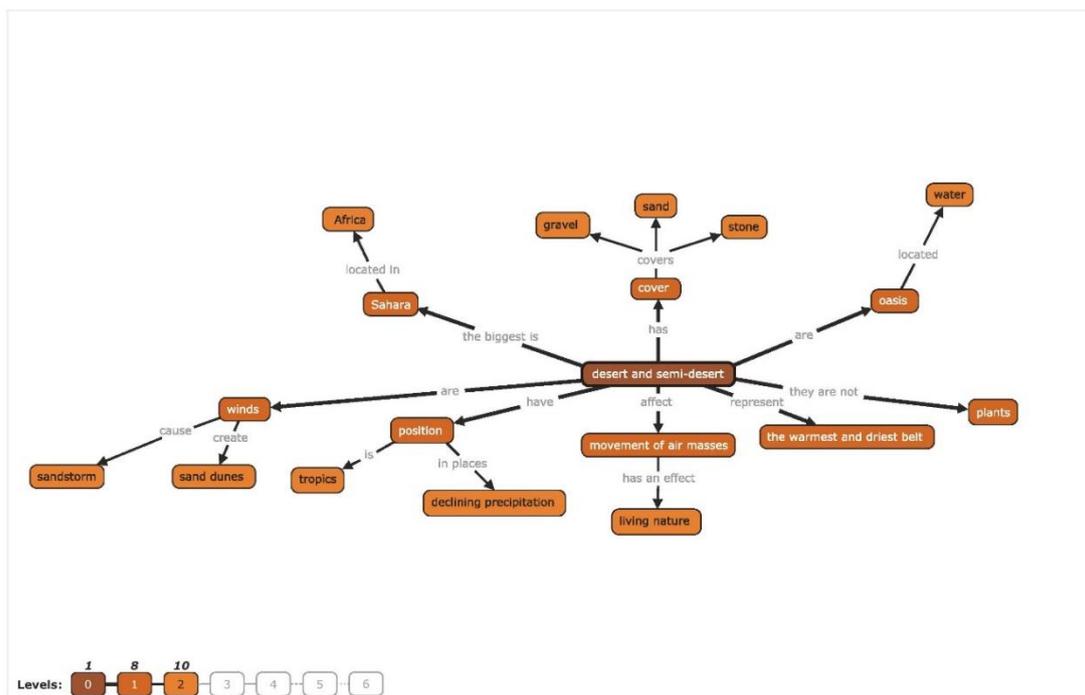
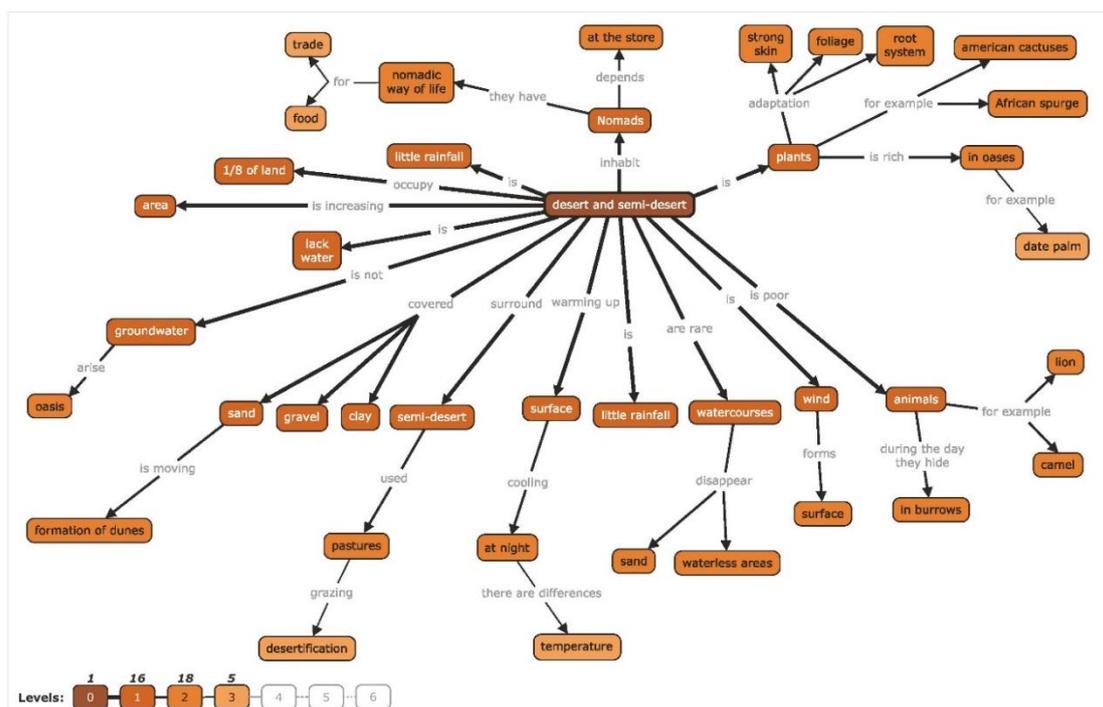


Figure 6: Conceptual map of the topic of desert in Textbook E (Státní pedagogické nakladatelství)



The presented conceptual maps show that all the textbook publishers build the chapters on deserts on three basic concepts: climatic zone, with an emphasis on minimal rainfall (or temperature differences between day and night); lack of water (in contrast to the occurrence of oases); and the specific nature of the biota, with examples. These three core topics illustrate the desert biome, according to the authors. The authors frequently use examples of plants and animals to illustrate the specificity of deserts; camels and cactuses are mentioned very often without any spatial context, i.e., in which region of the world they appear. This is associated with the lacking of descriptions of the impact of latitudinal and longitudinal zones on the locations of deserts. By omitting this, the authors eliminate the opportunity to present additional types of deserts (polar deserts, temperate deserts, etc.).

It is interesting to note that a part of the analysed textbooks focuses unilaterally on physical and geographical aspects of the geographic environment when presenting deserts and fails to take into account their socio-economic content. This text structure eliminates one of the key specifics of geography – the study of the relationships between nature and the society. This outcome suggests that textbook authors tend to build on the traditional conception of teaching biomes, in which the presentation of social activities is eliminated. However, identifying the relationships between nature and society is currently important, as biomes, including deserts, are intensively used and changed by human beings. On the other hand, the natural environment influences the character of society and its activities. If human activities are mentioned in the textbooks, they mainly include traditional economic activities (such as grazing), and never modern economic uses (such as oil mining, or tourism). It is important to note that while this information is not incorrect, it reinforces outmoded stereotypes, since these areas now feature much wider economic activity. This phenomenon is referred to below as stereotyping through examples. An overview of the problems identified through the conceptual maps of the analysed textbooks is shown in Table 2.

Table 2. Overview of problems in the presentation text concerning deserts in geography textbooks

Identified problem	Textbook A	Textbook B	Textbook C	Textbook D	Textbook E
Poor representation of the social content of the area (influence of the environment on humans)	NO (relatively poor, stereotyping but effort to show interconnection)	YES (missing entirely)	YES (missing entirely)	YES (missing entirely)	NO (however, people listed as biome components, stereotyping approach)
Absence of classification under deserts and semideserts	YES (but stated differently)	NO	NO	NO	NO (identification of the desert expansion problem needs to be assessed positively)
Distinction between hot and polar deserts absent	YES (cool and hot deserts distinguished)	NO	YES	YES	YES (missing entirely)
Absence of different surface covers in deserts (type)	NO (certain types are missing or are identified inaccurately)	NO (certain types are missing or are identified inaccurately)	NO (however, only sand and stone listed)	NO (certain types are missing or are identified inaccurately)	NO (certain types are missing or are identified inaccurately)
Conventional content-based approach	YES (waters, wind climate, plants and animals)	YES (waters, climate, plants and animals)	YES (climate, plants, animals)	YES (difficult to identify due to small volume of information)	YES (waters, wind – climate and surface, plants, animals)
Absence of the effect of latitudinal zone / location	YES (missing entirely)	NO (insufficient, subtropical zones)	NO (insufficient, tropics + 1 exception)	NO (insufficient, tropics, low rainfall)	YES (missing entirely)
Stereotyping through examples	YES (nomads, a few biota examples)	NO (several different examples provided)	YES (inland Asia + tropics, but many examples provided under biota)	YES (Sahara – Africa, sand)	YES (nomads, a few biota examples)

4.2 Results of quantitative analysis of conceptual maps

The interconnection of individual concepts is evidently weak in the textbooks studied. The authors mostly present each part of the geographical environment separately, without any effort to include the relationships between the individual components of the geographical environment (also see Table 2). The cross-links category (see Table 3) was only identified once. This result may indicate the continued prevalence of the traditional, content-based concept of geographical education in the Czechia; textbook publishers, their authors, and geography teachers use a relatively rigid concept of teaching geography in components, with minimal emphasis on the relationships and connections between them, which is reflected in the content of textbooks.

The quantitative analysis of the conceptual maps shows major differences between individual textbooks (Table 3). The total number of points depends strongly on the scope of the chapter, and this factor needs to be taken into account when interpreting the results. Textbook A presents deserts with the highest level of elaboration, while the lowest level of

elaboration was identified in Textbook D. When the results of the quantitative analysis are interpreted in light of the concepts in the chapters, it becomes evident that Textbook A places greater emphasis on relationships and connections in space, time, and individual components of the geographical environment than the other textbooks (for example, the textbook by Nová škola is structured by subchapters according to the geographical environment). However, minimal crosslinks were identified in the entire research sample. Significant variability was also identified in the number of visuals and examples provided in the textbooks (for example, significant differences were observed between the textbooks by publishers B and D).

Table 3. Results of quantitative analysis of conceptual maps

	Textbook A		Textbook B		Textbook C		Textbook D		Textbook E		Summary results for all textbooks (average)	
	<i>N</i>	Σ	<i>N</i>	Σ	<i>N</i>	Σ	<i>N</i>	Σ	<i>N</i>	Σ	<i>N</i>	Σ
Concept-links	48	96	59	118	29	48	18	36	39	78	38.6	75.2
Cross-links	1	10	0	0	0	0	0	0	0	0	0.2	2.0
Hierarchies	5	25	6	30	4	20	2	10	3	15	4.0	20.0
Examples	5	5	19	19	7	7	1	1	5	5	7.4	7.4
Visuals	11	55	3	15	9	45	1	5	5	25	5.8	29.0
TOTAL	×	191	×	183	×	120	×	52	×	123	×	134.8

5. DISCUSSION

The results of the analysis showed that the presentation of the selected biome is relatively rigid in Czech textbooks, which are based on stereotyping and do not interleave individual geographical components. The textbooks mostly limit their presentation to subtropical deserts and omit other types of desert (including the polar type), with one exception, identified in Textbook B. Students may therefore be under the impression that only one type of desert exists; students cannot differentiate between individual types of desert according to climatic zones based on the presentation of the curriculum in these textbooks. The connection between plants and animals and the desert areas in which they live can be seen as a major negative aspect. For example, although a student will be aware from the textbook that camels are typical examples of animal living in deserts, or that cactuses are typical desert plants, they will not be able to identify the region in which the animal or plant can be found. This may lead to stereotyping in the curriculum (often stereotyping through examples), based on excessive generalisation. This also leads to the occurrence of misconceptions, i.e., inaccurate perceptions of the living environments of certain types of plants and animals (see also Francek, 2013; Dove, 1999; Dove, 2016; Strommen, 1995; Rey-Goyeneche & Alexander, 2021; Trahorsch & Trhliková, 2021).

As mentioned previously, the structures of the chapters in the analysed textbooks mostly support the content-based approach to presenting the curriculum. Students are unable to seek relationships and connections between individual components of geographical environments independently. This defect is also apparent in the conceptual maps created in this study. Students may de facto lack a didactic aid that would support their ability to seek relationships between the components of geographical environments. Any changes to the structures of

these chapters should be based on changes to the concept applied to the presentation of the curriculum concerning biomes, rather than minor changes in the wording of the text; however, these changes may be obstructed by several problems, such as insufficient knowledge on the part of the authors, unsuitable choices of examples, etc. (Lee & Catling, 2017).

The content and selection of the key terms used in the textbooks we analysed cannot be considered suitable in view of the creation of children's conceptions. As mentioned previously, these chapters very often present traditional economic uses of geographical areas without paying attention to current economic issues. Examples of the modern uses of deserts should be supported by specific data, and sufficiently varied examples of phenomena and processes should be used when presenting examples.

The results show that the structures of the chapters in Czech geography textbooks have the potential to negatively influence children's conceptions because the textbooks' authors practically omit any application of modern psychodidactic knowledge (for example, the topic of cognitive conflict or constructivism—Vosniadou, 2013) from these structures. Specifically, we are of the opinion that the authors of the chapters do not make use of students' prior knowledge of and experiences with deserts, which display identical characteristics, according to specialised studies (for example Dove, 1999; Schubert, 2014; Schubert & Wrenger, 2016; Trahorsch & Trhlíková, 2021). The textbooks' authors are therefore unable to generate cognitive conflict in students, which is highly effective for changing children's conceptions (Reinfried et al., 2015). The increased use of abstract types of visuals to differentiate desert biomes around the world (such as climographs), maps of different desert types with regard to surfaces or zones (stone, sand, gravel, polar, moderate desert, etc.), charts showing the causes of the prevailing climate, diagrams illustrating water drainage for a more effective presentation of areas such as wadi, etc., would be appropriate. The current textbooks only include abstract descriptions of geographical conditions, which may be interpreted by students inaccurately.

The resulting concept maps may indicate a relatively low potential for the development of systems thinking (cf. Cox, Elen, & Steegen, 2019). The reason for this is the relatively small number of relationships between different thematic areas of geography, the minimal number of crosslinks, and the emphasis on examples of plants and animals. It is therefore questionable whether students using these textbooks would be able to modify their mental models to more accurate concepts or eliminate misconceptions through conceptual change (cf. Reinfried et al., 2015).

While we aimed to highlight the selection of the key terms and their relationships in the presentations of deserts, this study has certain limitations that need to be taken into account in subsequent work. Firstly, there was a certain degree of subjectiveness in the creation of the conceptual maps based on the texts, as is the case with the content analysis of any text. This limitation of the study was eliminated by involving a higher number of assessors in the creation of the conceptual maps and by creating a synthesised conceptual map for each of the textbooks (see West et al., 2000; West et al., 2002). Certain ambiguous concepts and their relationships could have been eliminated by applying this approach. However, it is necessary to point out that the creation and subsequent analysis of the aggregated conceptual map naturally led to the elimination of certain concepts that were less relevant to the chapter structures and their relationships (the generalisation of reality through the tool used to study it; Hallberg, 2013), despite their identification by some of the assessors. Although this methodology was applied several times, this characteristic of the methodology should be further elaborated through analyses of additional textbooks and phenomena in order to improve its accuracy. The assignment of a specific number of points for individual categories in the analysis (see, for example, the discussion in D'Antoni, Zipp, & Olson, 2009) or their major dependence on the scope of the chapter (compare Tables 1 and 3) may also be disputed. The results cannot be generalised uncritically to other geography textbooks or other chapters or phenomena in the analysed textbooks in view of the limited scope of the analysis (desert biomes). However, the results provide certain insights into the creation of the structure of the curriculum content and the potential learning processes of students. Therefore, it would be suitable to supplement this study with further research (for example, a comparison of the

conceptual maps from the textbooks with mind maps by students, their drawings, or their test results) to identify the relationship between the presentation of the curriculum in the textbooks and the creation of conceptions among lower-secondary-school students more precisely (compare, for example, with the research design in Strommen, 1995; Rey-Goyeneche & Alexander, 2021).

6. CONCLUSION

The significance of the presentation of the curriculum in these didactic aids is crucial for teaching-and-learning (Esteves, 2019), as well as the perception of the subject, i.e. geography, by the wider population as a discipline focusing on factographic data (specific data without any interpretation). The structures of geographical textbooks in the Czechia are based on outmoded content-based approaches to education that do not encourage pupils to spot connections between topics and do not include the relationship between society and nature. If sufficient attention is not paid to the selection of key terms in the chapter content and their relationships, the quality of didactic aids cannot progress significantly towards a more modern approach; rather, the Czech textbook content will become rigid and immune to any broader conceptual changes. Although this study was applied to Czech textbooks of geography, it is possible to compare the content of these textbooks with those of textbooks from other countries; furthermore, the study presents the application of a relatively innovative method of conceptual mapping in the analysis of geography textbooks. Nevertheless, the results show that new international trends are entering the Czech geographical education sector very slowly.

The chapter content of geography textbooks should reflect the abilities of students more closely, particularly their knowledge and experiences with the relevant topic (compare with Rye, 2013). It would also be advisable to pay more attention to the relationships and connections between individual components of the geographical environment (in particular, the relationship between the natural conditions and culture of a region), as well as their demonstration through suitable and varied examples or visuals (such as case studies of the lifestyles of different people). Changing the concept behind the structuring of chapters appears to be suitable. For example, a problem-based or system-based approach to the presentation of the curriculum could be used (de Sousa, Hay, & Liebenberg, 2019). This could involve progressing from traditional economic activities to modern social and economic arrangements instead of the systematic approach, which is unfortunately applied in all the textbooks we analysed. The application of this methodological tool in the analysis of texts by experts in various countries worldwide would also be advisable; the presented methodological tool could thus contribute to the networking of research in geography education.

The interpretation of the results showed that the production of textbooks has major shortcomings that negatively influence the work of students and teachers. This is why the quality of textbook content and the alignment of this content with the current state of knowledge in science and modern psychodidactic findings should be a core focus. If these principles continue to be ignored, the desired change in the effectiveness of geography teaching in lower secondary schools and the positive perception of geography as a subject by the wider population are not likely.

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