

# Learning geography by comparing apples to oranges?

**Theoretical approaches, international comparative  
analysis, development and testing of educational  
resources for the enhancement of comparison  
competency in geography education**



Inaugural-Dissertation zur Erlangung des Doktorgrades der  
Mathematisch-Naturwissenschaftlichen Fakultät der Universität zu  
Köln

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Köln 2024

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29. Oktober 2024

Kumulative Dissertation – Vorlage und Gliederung gemäß § 7 der Promotionsordnung der Mathematisch–Naturwissenschaftlichen Fakultät der Universität zu Köln vom 12. März 2020.

# FOREWORD & ACKNOWLEDGEMENTS

This dissertation is the result of several exciting years at the Institute for Geography Education at the University of Cologne, where I have been lucky enough to work since 2019. My first big THANK YOU goes to my supervisors, Prof. Dr. Alexandra Budke and Prof. Dr. Frank Schäbitz. Dear Alexandra, thank you for trusting me at the beginning of the project, for giving me the freedom to explore my topic while guiding me through it, and for your unwavering support and encouragement throughout this work. Dear Frank, thank you for your confidence, continued support and expertise while producing resources based on the results of the CRC-806.

I would like to sincerely thank Prof. Dr. Miriam Kuckuck for being 2<sup>nd</sup> Reviewer and examining the dissertation. I would also like to thank Prof. Dr. Peter Dannenberg for chairing the examination committee and Prof. (apl.) Dr. Günther Weiss for being minutes taker during the dissertation defence.

I would like to warmly thank my colleague and friend Dina Vasiljuk for the daily intellectual and friendly exchange and for her support in the critical phases. I would also like to thank my colleagues and former colleagues for their warm welcome, their support in the Research Workshop (Forschungswerkstatt) and the collaborative work: Dr. Frederik von Reumont, Dr. Eva Engelen, Dr. Verena Förster-Indenhuck, Dr. Veit Maier, Sonja Przyklenk, Dr. Karsten Schittek, Saskia Steingrübl, Dr. Ronja Ege, Klaas Enke, Dr. Wibke Erdmann, Florian Gabor, Katrin Geiger, Benoît Goffin, Dr. Johannes Heuzeroth, Kimberley Hindmarsh, Dr. Somaye Khademi, Dr. Matthias Krepf, Dr. Maxim Krohmer, Isabelle Kunze, Astrid Lütje, Joelle Lux, Nikolaus Repplinger, Robin Schönstein, Sarah Schwerdtfeger, Björn Soberg, Michelle Wegener, Dr. Sebastian Wolff-Seidel.

I would also like to thank the members of the CRC-806 who welcomed me with warmth, curiosity and enthusiasm. They have given me the opportunity to be part of an important and innovative project, and I would also like to thank them for generously making their results available for me to transform into teaching resources.

This work would not have been possible without the help and trust of the teachers and students who took part in the project, in particular my friends and colleagues at the Lycée Jacques Monod in France, my history-geography colleagues and in particular Juliette Le Cœur. Teaching with them was a wonderful experience, and carrying out the intervention there was a matter of course. Thank you also to Alice Heathwood for her help in the English language and to Jean-Robert Gicquel for his help as a rater in Study 1.

Finally, I would like to thank my friends and family in France and Germany who have been with me all these years, some encouraging me, others listening to me, in this new experience of a new country, a new challenge and a new profession. I'd especially like to thank my grand-mother, my parents and my brothers, Clément and Sylvain, for their love and their presence at my side, even from afar.

Dominic, this work is for you.

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## 1. Introduction

Many contemporary and societal issues, such as climate change and its consequences, or globalisation and the spatial inequalities it causes, are characterised by a high degree of complexity. The comprehension of such intricate geographical themes and issues necessitates the development of complex competencies, in order to be able to discuss and argue about possible solutions or decisions to make. To illustrate this with an example topic, climate change is affecting geographical spaces differently (IPCC, 2023) and human populations and local spaces are differently vulnerable to it (Thomas et al., 2019). Understanding to which extent climate change can have different effects on geographical spaces is very important if politicians, but also laypeople or students have to tackle this major challenge. To do this, one needs, among other possible methods, the comparison between geographical spaces as a tool for making decisions. To compare the effects of climate change on different populations and geographical areas, and therefore their vulnerability, several variables affecting population vulnerability can be employed. For instance, Thomas et al. (2019) consider the impact of differential access to resources based on social circumstances, the impact of climate change governance, the impact of access to information, and the risk culture of the populations concerned. The results of such a comparison may vary according to the areas considered and the factors taken into account, as well as their weight in the result of the comparison. Nevertheless, a comparison of this kind does enable an evaluation of the vulnerability of the areas concerned and, consequently, the formulation of potential adaptation or mitigation measures. Consequently, the capability to not only compare, but also to evaluate such comparisons of geographical spaces and to formulate a judgement about them represents a significant challenge, not only in the context of climate change, but also in relation to other scientific and societal issues. It is not only geographers, scientists and political decision-makers who require the ability to compare or formulate discourses, diagnoses or proposals for measures using such comparisons; the general public, lay people and students as citizens or future citizens must also be able to formulate, evaluate and even act on them. Consequently, this challenge extends beyond the scientific or political debate and encompasses the field of geography education, where it should be addressed.

More generally, fostering scientific knowledge and methodological approaches such as the geographical comparison is crucial, since some contemporary global issues exhibit a notable discrepancy between the scientific consensus reached by scientists - including geographers - and the beliefs held by the general public. For example, despite the accumulation of scientific data and conclusions, growing media visibility, a shift in the focus of education towards school

curricula on the subject, and public demonstrations, there is still a significant gap on a global scale between public perceptions of climate change and the facts accepted by the almost totality of scientists. Although 97% or 98% of scientists agree that human activity is responsible for the current climate change (Anderegg et al., 2010), members of the general public seem to be less convinced, with only 47% or 62% acknowledging the human origin of the issue (Hughes et al., 2023). This discrepancy between scientific consensus and public beliefs is not limited to climate change. Vaccine hesitancy (WHO, 2019) is another societal issue where a discrepancy with scientific results and discourse is visible (Kennedy, 2020). Similarly, in other geographical subjects such as migration studies, long-attested positive effects of migration on both origin and destination countries are also debated and sometimes questioned politically in the public arena (Badie et al., 2008).

How can a better understanding and discussion of such decisive and global issues be fostered? The mere dissemination of scientific or geographical knowledge appears to be insufficient in promoting awareness (for example, in the case of climate change, Kahan et al., 2012). There are different possible explanations for this. Firstly, this could be because scientific facts and knowledge are the results of scientific processes and discourses which are not well known. Scientists use a large and various set of scientific practices, methods and activities, which results in the generation of scientific discourses on obtained results. There are discussions between scientists on their methods, conclusions, and interpretations. They examine each other's works critically to validate or infirm their results. Therefore, scientific knowledge is built on discourse and language (Norris & Phillips, 2003; Osborne, 2023; Postman & Weingartner, 1971). Secondly, not all scientific subjects are undebated: there are scientific controversies in some subjects which need laypeople and students to be able to understand and compare the possibly contradictory knowledge claims and the controversy around them (Greene & Yu, 2016; Lang et al., 2021; Sinatra et al., 2014). Therefore, "to be able to think critically about a domain and its claims requires some knowledge of the domain, and that knowledge is built, at least in part, on the capability to read, write, and talk using the concepts and ideas of the discipline" (Osborne, 2023, p. 788). This competency to understand scientific issues, how they were produced and discussed, and to think critically about them is called scientific literacy. Scientific literacy supposes not only to master the content knowledge related to scientific questions but also to understand the processes by which scientists generate knowledge (Rychen & Salganik, 2001, p. 16; OECD, 2019b, p. 99) and to be able to evaluate and assess it. Drummond et al., (2016) already demonstrated that enhancing endorsement of scientific inquiry had a beneficial effect. Furthermore, for the topic of climate change, an investigation conducted by Hughes et

al. (2023) revealed that the understanding of scientific processes and methods was found to be more closely linked to belief in climate change factors than facts and knowledge. Consequently, there is a general need to enhance scientific literacy. Geography education, through the promotion of geographical knowledge and methodological approaches such as the comparison, can contribute to answering to this need.

To compare is to examine two or more units in relation to one or more variables in juxtaposition, to identify any similarities and/or differences (Namy & Gentner, 2002), based on a given question. Comparison serves as a fundamental cognitive process that enables the categorisation and comprehension of the world from an early age (Namy & Gentner, 2002; Loewenstein & Gentner, 2001). It is a classical rhetorical task and has been employed since the time of Aristotle as a means of discussing, arguing and persuading (Goyet, 2014). Comparison is utilised in numerous ways across the natural and social sciences, as well as geography. Comparisons are inductively or deductively employed to develop or validate patterns, typologies, theories and models for comprehending the world and various local situations (Burgess et al., 1925; Durkheim, 1967 [1895] ; Weber, 1995 [1921]). For instance, comparisons are a fundamental aspect of the construction of concepts and theories in social sciences and in geography. Nevertheless, comparison is not an unequivocal scientific practice, despite the assertion that science is fundamentally comparative (Durkheim, 1967 [1895]). In the fields of urban studies, human geography, and anthropology (Candea, 2018), comparison often takes a resolutely idiographic approach, utilising the local context as a point of contrast to provide insight into general processes. This approach involves a detailed description of local situations and the provision of contextual information through comparisons (Gervais-Lambony, 1994; Le Galès & Robinson, 2023; Pinson, 2023). Consequently, comparison represents a scientific method with significant theoretical and epistemological implications. Scientists from a range of disciplines, including geography and anthropology, engage in discussions and debates on these implications. These discussions encompass the possibility of generalisation while comparing, as well as the commensurability of comparison units (e.g. Descola, 2019; Detienne, 2002; Le Galès & Robinson, 2023). Therefore, it is imperative that comparison be taught in school geography, as this will contribute to enhancing scientific literacy and enable students to participate in societal debates while utilising scientific results obtained while using comparison. Some school subjects, such as physics or biology in the natural sciences (for example, in France: Ministère de l'Éducation Nationale et de la Jeunesse, 2023), or history in the social sciences (for example, in Germany: Ministerium für Schule und Weiterbildung & des Landes Nordrhein-Westfalen, 2014) already incorporate scientific methods as part of their curricula. In geography

education, there have been some attempts to teach geographical content and geographical methods through inquiry-based (Spronken-Smith et al., 2008; Weiss & Gohrbandt, 2018) or “Thinking Through Geography” teaching strategies (Leat, 1998). However, to date, no reflection on comparison as a competency for geography education and no intervention study teaching the comparison method have been conducted in geography education research. Moreover, while students may frequently engage in comparison tasks, no systematic analysis has been conducted to assess the nature of these tasks, their level of difficulty, or the students’ competency in comparison. In order to enable the assessment of comparison competency, it is necessary to model and evaluate comparison competency via rigorously tested assessment criteria. It is necessary to develop and test tools to enhance comparison competency. The objective of this dissertation is to address the existing gaps in the literature on these issues by answering the following research questions:

*(1) How can we model and assess comparison competency in geography education internationally, (2) how competent are students while performing geographical comparisons and (3) to what extent can tools or scaffolds contribute to enhance comparison competency?*

In order to address these questions, the dissertation will adopt a comparative approach. This will involve an international analysis of geography textbooks from Germany, France and England, as well as an intervention study with German and French students. This approach will enable the drawing of conclusions that may be valid above local or national school systems, and will enrich local analysis via the counterpoint of other systems and examples.

This dissertation was written as part of the Collaborative Research Center CRC 806 (Sonderforschungsbereich SFB 806)<sup>1</sup> project, which was supported by the German Research Foundation (project number 57444011 - SFB 806). This project, which brought together scientists from a wide range of disciplines from the Universities of Cologne, Bonn and Aachen from 2009 to 2021, had for its principal subject the dispersal of anatomically modern humans from Africa to Europe from the end of the Middle Pleistocene (approximately 200,000 years ago). The principal research questions addressed by the CRC 806 were as follows: “What reasons can be identified for this prehistoric migration? Was there one or more waves of emigration? Which routes were used?” In this project, an innovative approach was employed, integrating educational researchers tasked with investigating educational research questions while utilising findings from other CRC 806 projects, thereby facilitating the rapid

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<sup>1</sup> The website of the CRC 806 can be accessed here: <https://www.sfb806.uni-koeln.de/>

dissemination of scientific results to geography teachers and students. Prof. Dr. Alexandra Budke and Prof. Dr. Frank Schäbitz led this sub-project in the CRC and decided to research the following subject: comparisons using argumentations to study migration movements and culture interactions. Following the initial year of the project, during which Dr. Holger Wilcke and Prof. Dr. Budke developed the comparison method for geography education (Wilcke & Budke, 2019, see 2.2.4), this dissertation could commence on that foundation. Chapter 2 presents the theoretical background of this dissertation. Chapter 3 outlines the general methodology employed. Chapter 4 presents the five studies included in the dissertation, while Chapter 5 presents the comprehensive findings of the various studies and provides answers to the research questions. Chapter 6 then discusses the potential implications for geography education research and for geography education in practice.

## **2. Theoretical background**

This second chapter examines the theoretical stakes involved in teaching comparison as a geographical method in geography education. Comparison is an important tool for the acquisition of knowledge. This function of comparison has been long identified in the scientific literature in different research fields, including psychology, philosophy, and diverse natural and social sciences. However, there is not *one* handbook on comparative methodology. The diversity of comparative practices, moves and forms is striking, which presents a challenge in conceptualising comparison but also reflects the potentialities associated with it. The first section of this theoretical chapter therefore aims to explore the repertoire of possible forms that comparison can take as a tool for knowledge acquisition and for geography, and to assess the extent to which this spectrum of possibilities may have implications for comparison in geographical education (2.1). The second section of this chapter aims to present an overview of the current state of research on comparison in geography education. There are only few recent and consistent scientific approaches to comparison as a tool for geography education. This section of the chapter therefore also aims to identify the research gaps and to set out the aims of this dissertation (2.2).

### **2.1 Comparison as a tool for knowledge acquisition in the natural and social sciences**

There are various approaches of the term *comparison*, from different research fields. In this initial section, I propose an examination of the variety of approaches to comparison, replacing it in a broader (western) history of knowledge acquisition and scientific practices. It is often the case that theoretical approaches to comparison can be found in geography's neighbor disciplines such as psychology and cognitive sciences, philosophy and rhetoric, anthropology and sociology, political and social sciences, which have long reflected on comparison as a means of knowledge acquisition or as a method. Each of these approaches may have consequences for how students may already be confronted with comparison in European school systems and therefore in geography education. Therefore, in this section, an analysis of comparison in different disciplines and in geography is led to draw possible consequences for geography education and identify possible research gaps. Approaches from various research fields define comparison as a fundamental cognitive activity (2.1.1), a classical rhetorical task (2.1.2), an instrument to gain knowledge and a scientific method (2.1.3) involved in nomothetic processes (2.1.4). Geographers employ also comparisons to construct laws (2.1.5) and to analyse today's world (2.1.6). Other approaches have been critical of nomothetic comparisons (2.1.7) or rather theorise comparison as a whole process (2.1.8).

### **2.1.1. Comparison: a fundamental cognitive activity**

A common starting point when attempting to define comparison is to refer to it as a fundamental cognitive activity (e.g. Piovani & Krawczyk, 2017, p. 822). In these approaches, comparison is described as an essential and universal aspect of human thought. Some authors even refer to humans as "comparative animals" (Boswell et al., 2019, p. 7). Nevertheless, other authors have also criticised this common starting point as a "commonplace" (Candea, 2018, p. 4). It is therefore important to examine it, in order to consider how students compared as young children and may compare spontaneously, aside from any scientific method or educational task.

Researchers from the fields of psychology and cognitive sciences have investigated the role of comparison as a fundamental cognitive activity. In these works, comparison is defined both as a process and as the result of this process. From an early young age, children are able to perceive similarities between objects and align them to identify either commonalities or differences (Gentner & Namy, 1999, p. 509). Gentner & Rattermann, (1991, pp. 227-229) identify a "career of similarity" which explains how very young and young children (from a few months old to 15 years of age) compare (see Figure 1).

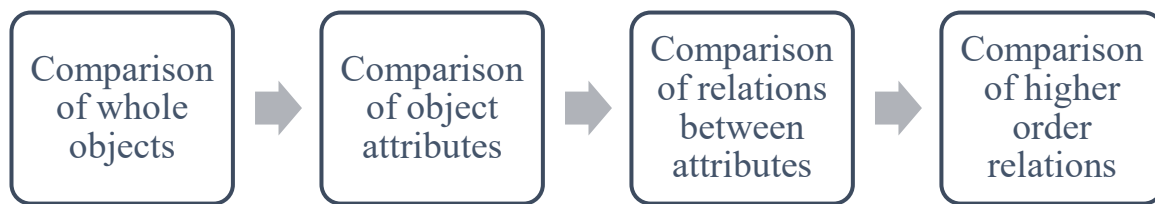


Figure 1: Career of similarity. Adapted after Gentner & Rattermann (1991, pp. 227-229).

The initial stage of cognitive development is characterised by the formation of a perception of similarity related to whole objects or objects in their entirety. In a second stage, children are able to identify similarities between objects' attributes. The third stage is the identification of relational similarity between objects' attributes. Finally, children (around 10 years of age) progressively gain the ability to identify similarity based on higher-order relations, which require the use of general concepts such as symmetry. The progression between these stages is related to the acquisition of more knowledge on the subject matter, to more experience and to the age of the children.

Cognitive and psychological scientists have also demonstrated that comparison processes facilitate children's understanding and categorisation (Gentner & Namy, 1999; Namy & Gentner, 2002), the formation of abstract rules and their application to novel examples (Gick & Holyoak, 1983). Thus, comparison is not merely the juxtaposition of entities or units and an "assessment of similarity". It allows for a better understanding of those units (Goldstone et al., 2010, p.119). In numerous disciplines, cognitive psychologists and researchers analyse comparison as a cognitive and powerful tool that contributes to learning. For instance, comparison is essential to the development of spatial thinking (Loewenstein & Gentner, 2001), to the understanding of mathematics (Rittle-Johnson & Star, 2011), the understanding of the fundamentals of scientific reasoning (Chen & Klahr, 1999), or to the application of business and negotiation strategies (Gentner et al., 2003).

### **Consequences for geography education:**

The act of comparison is a fundamental cognitive process employed by young children to make sense of the world. It is also a cognitive tool that is used by everyone. This process facilitates the development of abstraction and categorisation skills, which are employed by all individuals on a constant basis. Counting on this cognitive capacity of children, already from a young age, can be interesting since it can be trained and linked to general concepts. Students in geography



classes may be accustomed to comparing things in this basic cognitive way, as they have been doing this since infancy in their everyday lives and as learners. Nevertheless, although this cognitive process is powerful (Goldstone et al., 2010, p. 105), it is not a formalised, reflected scientific method for geography education.

**2.1.2. Comparison: a classical rhetorical task**

Comparison is a classical rhetorical exercise, cited by Quintilian and used since Antiquity (Goyet, 2014, p.160). In this form, to compare is a central “figure of thought and speech” (Mauz & von Sass, 2011, p. 4). In this tradition, comparison can be defined as the parallel drawn between two elements to find their similarities and differences, often to show the superiority of one over the other. Comparison in this case is defined as a reflection task (*comparatio*) based on the argumentative opposition between the terms being compared, in a dialectical movement (see Figure 2).

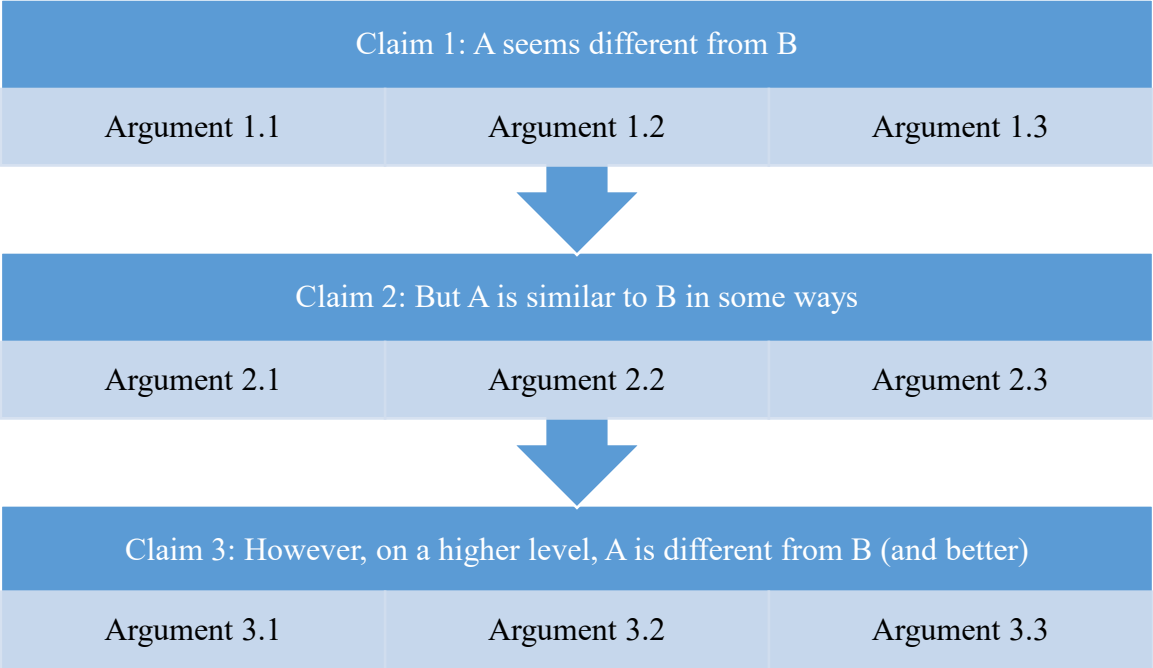


Figure 2: Comparison as used in dialectical and rhetorical exercises and in the French *dissertation*. Own elaboration after Denizot & Mabilon-Bonfils, 2012.

This dialectical movement supposes a comparing subject using comparison as an argumentation technique to convince a recipient of the comparison (Goyet, 2014). This comparing subject compares from a specific position which is not neutral. Comparison supposes to master language and argumentative tools and to be able to communicate, to write and structure the

comparison (Budke & Simon, 2021, p. 171). The recipient of the comparison can also assess and discuss the quality of the argumentation or of the comparison (Simon & Budke, 2021, p. 240). Moreover, this supposes to choose some comparison elements to better argue, very often in a teaching or learning environment. Comparison as a rhetorical task is therefore a very powerful argumentative tool designed to convince. As is the term argumentation, the term comparison refers therefore to a process and at the same time to a result (Eemeren & Grootendorst, 2004; Gutmann & Rathgeber, 2011).

But, comparison in this sense must also be replaced in a specific cultural, historical and social context: it is the product of a specific European conceptual history and is therefore culturally and sociologically situated (Candea, 2018, p. 6). Traditionally practised by European intellectual and cultural elites, comparison in rhetorical exercises presupposes a particular positioning of the person comparing: that of a superior subject, endowed with conceptual mastery, located above the objects being compared. Comparison is thus often associated with the risk of an ethnocentric stance on the part of researchers. Many works in the early development of comparative disciplines in the 19<sup>th</sup> century adopt this problematic approach and/or do not reflect on this risk while using comparison. In this context of the establishment of comparative sciences and of European colonization, the first modern geographers using comparison often compare new “discovered” comparison units - colonized peoples and their spaces – to their own societies and, using the *comparatio* rhetoric, draw Eurocentric or racist conclusions. This is visible in many early geographical works which adopt deterministic views (Livingstone, 1991, p. 415). For example, Hunt compares climatic regions of the world and draws deterministic conclusions about characteristics on their inhabitants, concluding to higher intelligence in temperate regions (Livingstone, 1991, p. 416). These deterministic approaches while comparing spaces or countries are still to be found in numerous geographical works in the 20<sup>th</sup> century.

### **Consequences for geography education:**

These elements and legacy of comparison as a rhetorical task have different consequences when considering comparison as a scientific method to be taught in geography education. This task is still practised in France with the specific essay named *dissertation*, in the English-speaking world with essays of the “compare and contrast” type, and in Germany with essays opposing thesis and antithesis as taught in German classes involving the specific task that is *Erörterung*. For example, in the 2022 geography exam for the French *Baccalauréat* [A-levels] which validates secondary education in France, students had two hours to argue on the following

subject: “The United States of America and the environment at different scales” (Ministère de l’Education Nationale, 2022, translation by author). In their essay, many possible comparisons were expected: between different scales, but also between different time periods.

In this respect, comparison as the *comparatio* task is already present in school systems and in tasks that are sometimes still practised today. The task culture in European countries is now changing, towards more output- and competency-oriented curricula (Klieme et al., 2007; Koch & Laske, 2014; Thémines, 2016; Young, 2014), but comparison in this rhetorical task form is still present in the school cultures and social practices of geographers, teachers, and maybe students using comparisons. This classical task influences the school culture and that of scientists who later use comparison in their work.

### **2.1.3. Comparison in the history of sciences (I): from an instrument to gain knowledge to a formalized scientific method**

Prior to analysing the extent to which comparison can be defined as a scientific method, it is necessary to consider the links between comparative techniques and knowledge production more generally. Comparison has been identified as one of the ways of acquiring knowledge since ancient times. For example, Aristotle outlines in his *Topics* (1882, 1.16-1.18, pp. 23-24) how the identification of similarities and differences serves as an instrument (*organum*) for reasoning and constructing arguments. For him, identifying differences in the comparison between objects enables two key outcomes: firstly, the assertion that they are different, and secondly, the definition of these objects in terms of their essential differences. Conversely, identifying commonalities between objects allows for inductive reasoning, the formation of definitions and categorisation, and the uncovering of the underlying universal principles. Aristotle thus identifies the cognitive power of comparison as a tool for knowledge acquisition. In its various applications, comparison has become a fundamental tool for the construction of knowledge. In *The Order of Things: An Archaeology of the Human Sciences*, Foucault (1966) demonstrates how various forms of comparison facilitate the identification of different *episteme* (defined as “the historical foundation[s] that make knowledge possible” (translated from Vuillemin, 2012, p. 40)). For example, the practice of reasoning by analogy and identifying similarities is an essential aspect of the *episteme* of the 16<sup>th</sup> century (Foucault, 1966, p. 45). Comparison, as a systematic method of analysis aimed at establishing identity or difference between objects while constructing typologies or asserting universal laws, is fundamental to the classical *episteme* of the 17<sup>th</sup> century, which is influenced by Descartes (Foucault, 1966, p. 68).

Indeed, classifications, typologies and taxinomies, which aim to categorise by comparison, are common practices in the 17<sup>th</sup> and 18<sup>th</sup> centuries.

Comparative tools and techniques from the classical *episteme* are essential to the development of comparative disciplines in the 19<sup>th</sup> century (Mauz & von Sass, 2011, p. 4) and to the constitution of modern sciences which form the new “modern” *episteme* (Foucault, 1966, pp. 357-358). The modern *episteme* is characterised by an abundance of different scientific discourses, but also by the emergence of other (comparative) social sciences in which human beings are present as both object and subject of analysis (Foucault, 1966, pp. 364-365). In fact, the 19<sup>th</sup> century sees the emergence and formalisation of various young and new disciplines that use comparison and classification as a means for acquiring scientific knowledge. These include comparative anatomy, comparative linguistics and comparative geography (Goyet, 2014), as well as social sciences such as sociology and anthropology (Candea, 2018; Descola, 2019).

These new modern disciplines also theorise their scientific character in the 19<sup>th</sup> century. With regard to comparison, the most prominent account comes from John Stuart Mill (1856), who theorises the comparison of different observations not only as a way of producing knowledge, but as a “scientific” method - as scientific as experimentation in the natural sciences - while formulating methods of induction. For Mill (1856), considering long lists of units of comparison, identifying similarities between them, and inducing generalisations from them is not a satisfactory way of using comparison. Consequently, Mill defines methods of induction to be used, three of which use comparison in various forms. First, he proposes the “method of difference”, which compares rather similar comparison units that are similar but differ in one variable. Second, he formulates the “method of agreement”, where otherwise very different comparison units are observed to share a common phenomenon. The “method of concomitant variation” makes it possible to identify causal relationships between two parallel phenomena. For Mill, these different methods of comparison can be applied by having “recourse (...) either to observation or to experiment” (Mill, 1856, p. 411). This assertion legitimises as “scientific” common methods from social sciences such as anthropology or geography, which use observations in fieldwork or ethnographic research, while making comparisons between observations. Mill also defines typology as a common scientific device, based on abstraction, which allows classes to be formed on the basis of identifying similarities between phenomena, that is, by means of comparison (Mill, 1856, p. 337). Finally, Mill himself recognises that social facts, because of their high complexity, can have multiple causes. As a consequence, inductive methods cannot always explain these facts causally. Mill therefore proposes the use of a deductive method. This method consists of constructing laws based on the analysis of simple

cases, and testing these laws comparatively by studying more complex cases. Mill's definitions of scientific methods using comparison are fundamental to many natural and social sciences that use inductive or hypothetico-deductive procedures or typologies and classifications as tools to formulate scientific claims.

#### **2.1.4. Comparison in the history of sciences (II): a nomothetic process**

Since it was theorised as a scientific method in the 19th century, comparison has been used in many ways in the natural and social sciences. The method has become a source of contention, with opposing approaches challenging its efficacy. These approaches claim uses of comparisons that reveal different theories and epistemological positions.

A first approach, which can be described as a “comparative orthodoxy” (Pinson, 2023, p. 234), can be found in sociological (e.g., Durkheim, 1967 [1894]), p. 124) and anthropological works (e.g. Radcliffe-Brown, 1951, p. 22). Based on Mill's validation of the observation and comparison of social facts as a “scientific” method (Mill, 1856, see 2.1.3), this approach aims to use comparison to generalise on the basis of particular observations. The objective of this form of positivist comparative approach is nomothetic: social and political scientists seek to identify social laws, concepts or factors that can causally explain the development of societies (Piovani & Krawczyk, 2017, p. 823; Tilly, 1984, p. 87). They either rely on induction and build theory based on different cases (Lijphart, 1971, p. 692), or they test hypotheses in a deductive way (Lijphart, 1971, p. 692; Tilly, 1984, p. 116). When induction is used as a way of constructing rules, anthropologists such as Radcliffe-Brown (1951) also use it as a way of categorising and classifying units. Typology is thus a preliminary step before establishing laws through induction (Candea, 2018, p. 87).

In order to achieve these goals, in this approach, scientists make specific choices involving comparison units. This requires, for example, the selection of “comparable” units of comparison (Pinson, 2023, p. 235). The objective, variabilistic, is to analyse how changes in comparison variables can elucidate discrepancies between units. Comparative procedures in this approach therefore involve testing and weighing variables. Furthermore, it is assumed that the units are given, easy to isolate and do not necessitate “construction” or definition (Pinson, 2023, p.235; Candea, 2018, p. 35). Comparativists using this approach also prefer to consider numerous units of comparison (“large-N comparisons”) (Liebersohn, 1991, p. 318). They either choose rather similar units, following Mill's “method of difference” or the “Most Similar Systems Design”, in order to control for variables more easily, or select rather different units, following Mill's

“method of agreement” or “Most Different Systems Design”, in order to better examine a common variable between them (Anckar, 2008, p. 390; Przeworski & Teune, 1970, p. 34). This approach also assumes that units are discrete; only in the case of diachronic comparisons are the units the same in time, allowing processes to be identified in a nomothetic way (Azarian, 2011, p.116). Researchers using this approach often favour quantitative methods with large data sets.

In this nomothetic approach, comparison is conducted through a series of steps that may vary in their sequence and structure, depending on the objectives and the manner in which knowledge is generated (e.g. through induction or deduction). In the field of anthropology, for example, Tylor (1889) identifies correlations between variables in different units in a first step, then develops hypotheses to explain these correlations in a second step, before testing these hypotheses on different units of comparison in a third step. Radcliffe-Brown (1951) identifies typology as a first step before induction and generalisation to find laws. For Evans-Pritchard, comparison takes place in three distinct moments. Initially, while translating, a "frontal" comparison is made between "primitive people" and one's own culture. Secondly, abstraction is employed to identify patterns or underlying forms of that society. Thirdly, a "lateral" comparison is made with other cultures (Evans-Pritchard, 1950, pp. 121-122).

### **Consequences for geography education:**

Comparison has long been recognised as a way of gaining knowledge in the natural and social sciences, and some of its forms are present in geography and school cultures, such as the construction of analogies or typologies. Nomothetic approaches are fundamental to the emergence of scientific theories, models and concepts, which in turn are fundamental products of scientific reasoning in developing explanations and solutions to experimental observations or problems (Osborne, 2013). Comparison is part of these processes in various forms. It may be employed at the outset of an investigation through the creation of typologies, or it may be employed inductively through the comparison of examples, leading to the generation of generalisations. Alternatively, it may be employed deductively, whereby models and theories are confronted with further examples, with the aim of either confirming or weakening hypotheses. All of these forms of comparison are part of the scientific repertoire of possible moves and steps in doing science. The processes of induction and deduction can be employed as a means of guiding students towards the acquisition and development of rules and concepts, while articulating them with examples in science (Osborne, 2013) and in geography education (Hugonie, 1991; Köck, 1980). For example, in a textbook for educators (Hugonie, 1991, p. 15),

the following table delineates the two inductive and hypothetico-deductive methods as the fundamental approaches to geographical inquiry, illustrating the diversity of different steps where comparisons can occur (see Figure 3).

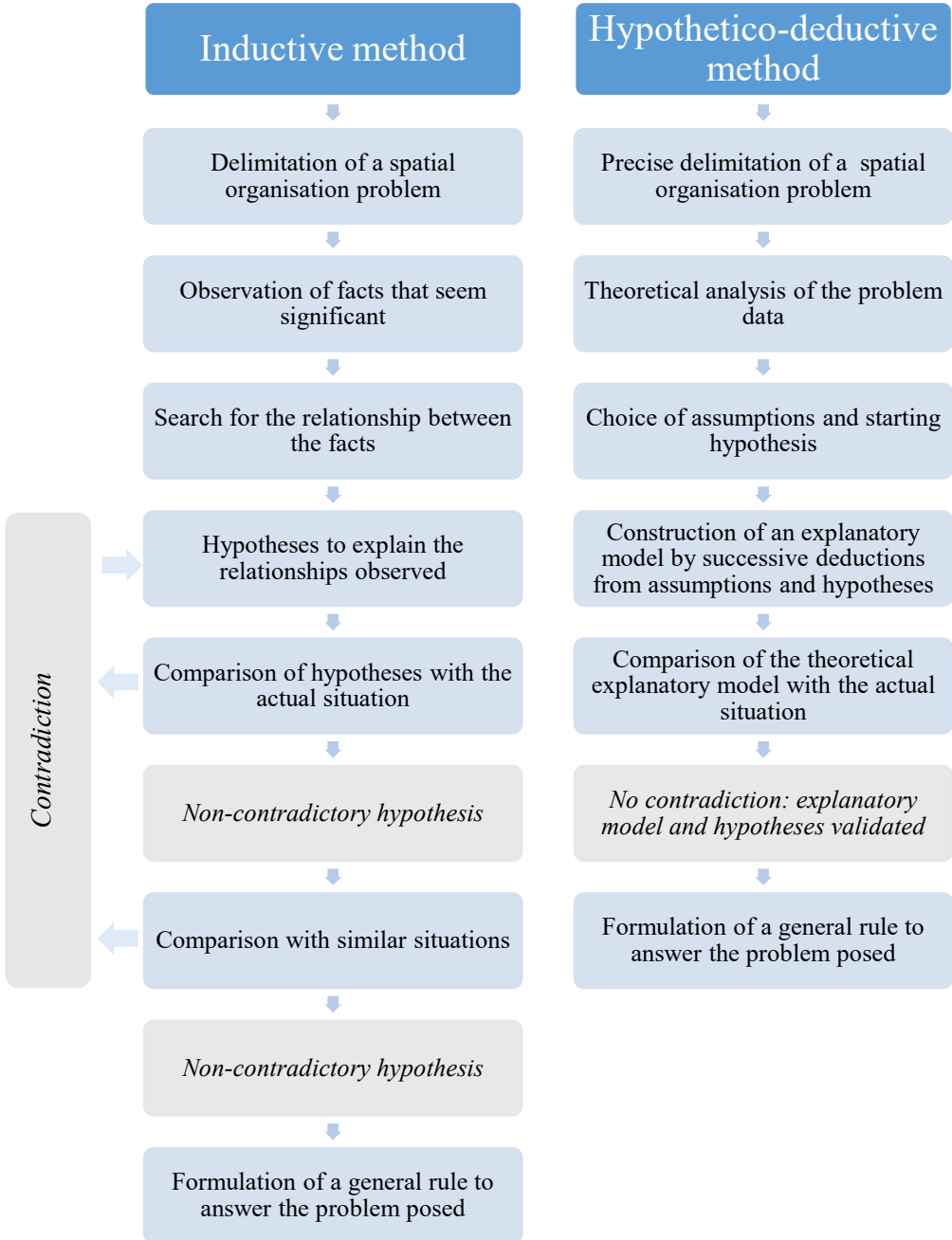


Figure 3: Inductive and hypothetico-deductive approaches in geography as presented in a French book for educators (Hugonie, 1991, p. 15). Own translation.

### 2.1.5. Geographers and comparisons (I): from absent comparisons to comparisons to exemplify or test laws

In geography, Carl Ritter wants to use comparison in geography as in other sciences (Ritter, 1865, p. xxiv) and mentions the comparative method in his introduction to his work as essential for the constitution of geography as a science: “in geography, the personal study of the earth, with critical closeness, and in the comparative method, is the true way” (Ritter, 1865, p. xxvii). Furthermore, he advocates the use of induction to formulate laws and theories about spaces based on specific observations. Alexander von Humboldt also attempts to integrate specific observations into a general account of the universe in his *Kosmos* (Humboldt, 2014 [1845]). Nevertheless, a significant proportion of geographical works published until the second half of the 20th century concentrates on monographs and the analysis of regions. In France, Paul Vidal de la Blache publishes his *Tableau de la Géographie de la France* in 1908, which lays the foundation for a long French tradition of regional monographies (Vidal de La Blache, 1908). In Germany, the concept of *die Landschaft* [landscape, region] serves as the main geographical object upon which the work of geographers is based (Hard, 1970). In both traditions, regions are regarded as singular and even exceptional entities. The aim of geographical analysis is not to make comparisons between them. There is a paucity of works that compare these monographs or reflect on the establishment of scientific laws or theories through comparison. Only Hartshorne describes geography as consisting of regional analyses and descriptions, which, through comparison, come together in a broader systematic analysis that enables the explanation of geographical and spatial differences (Hartshorne, 1939, p. 644).

With the development of spatial analysis and quantitative geography, different geographers criticise the first monographic and regional approaches and advocate for a greater theoretical foundation (Harvey, 1969; Schaefer, 1953). In France and Germany, geography also undergoes an epistemological and paradigmatic shift during this period. At the German Geographers' Day in Kiel in 1969, a group of young geographers call for a more theoretical and general geographical analysis (Schamp, 2007; Wardenga, 1987). In France, geographers influenced by the New Geography movement also begin to work on theoretical and nomothetic approaches to space (e.g. Claval, 1981). These debates are indirectly related to the use of comparison, either to criticise it, or to propose new ways of comparing. For example, Schaefer (1953, 238 ff.) criticises the exceptionalism associated with monographies, which tends to evacuate theory. The conception of geography as a methodological exception among other sciences would prevent geographers from pursuing robust theoretical and generalising approaches. Quantitative



and positivist approaches are generally concerned with the fallacies associated with monographs or regional studies. They claim, for example, that the accumulation of case or regional studies is not sufficient to build theory through comparison without proper testing of causal relationships or correlations (Kitchin, 2015). Harvey's book *Explanation in geography* (1969), represents a further development of the positivist approach to geography. Although the inductive method is still present in his work, he favours the hypothetico-deductive method, which enables geographers to utilise hypotheses, laws, theories and models for testing and confrontation with reality – that is, through comparison. Following this new geography of spatial analysis, numerous geographers employ theoretical models that they subject to rigorous testing and validation through comparison. For example, Pumain et al. (2015) seek to test Zipf's rank-size rule (1949) for the distribution of cities through comparison.

### **Consequences for geography education:**

Until the end of the 1960s in West Germany and the end of the 1970s in France, geography education and geography curricula are strongly influenced by the regionalist and monographic approaches, which tend to focus on the region and a largely descriptive and almost encyclopaedic approach to geographical facts (Lefort, 1998; Wardenga, 1987). Elements or traces of these approaches are sometimes still present in geography curricula (Fridrich, 2013). Finally, debates about the emergence of spatial analysis in geography science also have an impact on geography education. In his article "*Allgemeine Geographie statt Länderkunde!*" [General geography instead of regional studies, translation by author], Arnold Schultze (1970) explains how general geography allows to "concentrate on what is not unique, *what is similar and comparable in other regions*; its results should be valid beyond the specific object" (p. 2, translation by author, emphasis added). For him, the isolated study of countries or landscapes is an inadequate approach, and it should be possible in geography education to teach general geographic structures through examples before further comparisons, rather than teaching about different landscapes without generalisation. In his article, he presents several proposals for a geographical curriculum, all of which include the study of general concepts through different examples or case studies. This utilisation of case studies to illustrate general concepts represents a novel approach to the organization of geography teaching (Hard, 1982). Case studies are a pedagogical and educational tool employed in geography curricula (e.g. in France: Ministère de l'Éducation Nationale, 2000; in England: Department for Education and Skills & Qualifications and Curriculum Authority, 2004, p. 102). In France, case studies are supposed

to be used to compare with other cases or scalar levels, to generalise and thus to proceed by induction to build rules (Le Mercier, 2010, pp. 63-66).

#### **2.1.6. Geographers and comparisons (II): comparisons at the heart of today's geographical analysis and debates**

Despite epistemological debates and hesitations, comparison runs through geography. It is a basic tool for geographers who use indicators, scales and units of comparison to analyse and interpret spatial organisation and inequalities. Comparative movements and practices have become a permanent feature of geographical work. More than debates on the process of comparison and the objectives of comparison *per se*, scientific discussions revolve around the choice of comparison units, scales, comparison variables, but also around the comparison results, their presentation, and their interpretation.

A significant proportion of analyses in economic and social geography starts from the assumption of an unequal world, which is the result of comparing countries. On a global scale, economic geography constantly analyses the results of this comparison. This field of study is founded upon comparison, with the aim of measuring inequalities, interdependencies, and the problems and solutions to inequalities (UNESCO, 1985, p. 3). With the emergence of global indicators and data to assess the growth or GDP of countries, and the ongoing work of international institutions (UNCTAD, World Bank, OECD, ILO) or even private institutions (Crédit Suisse) to produce and update global data, it is now possible to analyse inequalities between countries. As a consequence of these international comparisons, the geography of development proposes typologies that group countries according to their economic characteristics. The concepts that underpin these classifications, including “developing countries”, “industrialised and developed countries”, “tigers states”, but also “emerging economies”, “BRICS” or “less advanced countries”, serve to define this unequal world (Bouron et al., 2022). However, they are also subject to significant criticism, such as the terms “development” or “third world”, which has led to a preference for other terms such as “global south” (Capdepuy, 2023). In order to explain the changes in global hierarchies, it is necessary to undertake a diachronic comparison of countries in order to study their trajectories. Furthermore, contemporary research endeavours to elucidate or evaluate the ongoing processes. Does the phenomenon of globalisation facilitate convergence or divergence among states? Does inequality drive dynamism? Does the national unit remain a relevant analytical framework for examining inequalities at the global level? (Dannenberg et al., 2018, pp. 87-89). Finally, current

analyses propose to study the phenomena of inequality production at different scales (Dannenberg et al., 2018, p. 88). Other authors reflect on how global inequalities are socially perceived through “othering” practices (“to set oneself (and the group to whom one feels related to) apart from ‘the other’, but also to feel as if one is in a (somewhat) superior position” (Franz et al., 2018, p. 110; Kitzinger & Wilkinson, 1996)). Their analyses demonstrate how the resulting comparisons contribute to the social construction of spatial inequalities.

These debates are not confined to academic circles: the question of inequalities, how to measure them and how to reduce them is, for example, a fundamental principle of the German constitution. This objective is enshrined both in Article 72 Paragraph 2 of the German *Grundgesetz* and in Paragraph 1 Abs. 2 of the Spatial Planning Act. At the level of international institutions, development aid programmes are the response to development inequalities. In the European Union, the cohesion policy is also fundamental to reducing inequalities. The European Union has created its own units of comparison, the NUTS (Nomenclature of Territorial Units for Statistics), in order to map inequalities at European and regional level and thus legitimise the allocation of European Regional Development Funds (ERDF). Three categories of regions have been defined: less developed regions, regions in transition and developed regions. Here too, the analysis of disparities is an issue for political debate and thus a factor in decisions regarding the allocation of funds: should the most disadvantaged areas be favoured or should the competitiveness of areas that are already striving be strengthened in order to remain globally competitive? Comparisons are thus not neutral: they serve as the fundamental arguments that legitimate political decisions, investment of public funds and development policies.

### **Consequences for geography education:**

Comparison is an essential instrument for analysing, interpreting and making decisions in today’s world. Comparisons at different scales are discussed in geography science but also in the media and in political debates, for example on the allocation of financial resources. Public and scientific discourses on these comparison variables, comparison units and comparison results are not neutral. On the one hand, students can be confronted with these discourses. On the other hand, as future voters, they must also form their opinions and make decisions based on these comparisons. Consequently, they must also be able to deconstruct or understand them. The ability to deal with political discourses and to form judgements about political issues is defined as maturity (in German: *Mündigkeit*) and is an important part of political education, which to a large extent takes place in geography education (Budke & Kuckuck, 2016; Kuckuck,

2014). Curricula in geography deal with these issues of spatial inequalities and potential solutions (e.g. Ministère de l'Éducation Nationale, 2019, p. 13; Ministerium für Schule und Weiterbildung & des Landes Nordrhein-Westfalen, 2014, p. 32); therefore, comparisons that students are confronted with or that they make can also have a political dimension. Scientific discourses using comparisons are also present in the public sphere and need to be analysed and deconstructed by students.

### **2.1.7. Criticisms in science and in geography towards nomothetic and generalizing comparisons**

Various criticisms have been made of comparison as a scientific method in a nomothetic approach. The majority of objections originate from anthropologists, given that comparison has long been established and considered as the central scientific method of the discipline, and therefore much discussed. Firstly, there are “problems of mapping” (Candea, 2018 pp. 34 ff.). In the positivist and nomothetic approach, comparison requires comparison elements (units, variables and relations between them) that are clearly definable and discrete, and very often “commensurable”. However, comparison units employed in anthropology, such as “societies”, and in geography, such as “regions”, are social and scientific constructs that may not correspond to social or geographical realities or experiences and that may overlap. The categories used for comparisons may be relevant to some social or geographical realities (often, those of the individual engaged in the comparison), but not to the geographical spaces being analysed for comparison. Moreover, according to Mill’s theories (Mill, 1856, see 2.1.3), the geographical spaces or societies compared must be independent and discrete if one is to assess how a variable affects them. In a globalised and interdependent world, this is a challenging, if not impossible, condition to observe (Candea, 2018, p. 36). Furthermore, global indicators such as GDP are also subject to criticism. These indicators often fail to differentiate between regions within a country or between cities and peripheral areas, where inequalities are also evident.

Finally, this “mapping” problem is linked to issues of “communication” and “purpose” (Candea, 2018, pp. 40ff). The individual undertaking the comparison (i.e., the social scientist or the geographer) is not situated in a neutral position: what is the relationship between the social scientist and their comparison units – who “controls the comparison” (Lloyd, 2015, p. 31), and what is their comparison for? In human geography, such critiques also apply to “mapping” and scales of analysis, but also to comparison units or variables such as “state”, “development”, constructed categories commonly used in development studies (Kuus &

Agnew, 2007). Others argue for a more complex and critical analysis of possible geographical actors, scales and power relations (Mitchell et al., 2019). Since the linguistic turn, critical geopolitical geographers also analyse and reflect on the use of categories and language as a tool of power (Ó Tuathail, 1996; Reuber & Wolkersdorfer, 2001). The question “Who is speaking, from where, about what and for whom?” is at the centre of this approach (Reuber & Wolkersdorfer, 2001, p. 7, translation by author). When applied to geographical comparisons and their results, such a critical analysis would take into account the fact that comparisons are argumentative constructs that imply a specific discourse about geographical places. Following Reuber and Wolkersdorfer’s analysis, when observing a comparison, one would have to ask: “Who is comparing, from where, about what units and what variables, and for whom?”.

Another debate revolves around the issue of commensurability and the choice of comparison units. In the positivist approach, the “comparability” of the units of measurement is a fundamental requirement for any meaningful comparison to be made. For example, in the context of the 19<sup>th</sup> century and the political construction of nation-states, numerous social scientists and historians are reluctant to make international comparisons, arguing that national differences are too important and that comparison units (nation-states) are therefore incommensurable. Such approaches are debated. In the field of history, Marc Bloch (1928) argues that international comparison allows a departure from monographs and goes beyond current or old analytical frameworks, which often remain national in scope or limited to specific bibliographies, languages or contexts. Marcel Detienne (2002) also proposes to “compare the incomparable”, by constructing comparison units and variables not from theory but from an initial case. In anthropology, structuralists propose a conceptual change regarding comparison units to overcome this problem of commensurability (Descola, 2019; Levi-Strauss, 1958). They distinguish between homology and analogy, opting for the latter, and compare theoretically constructed systems of relations, rather than generalising on the accumulation of social entities or phenomena chosen for their “family resemblance” (Descola, 2019).

These critiques and debates are not confined to the social sciences and anthropology. In geography, and urban studies in particular, nomothetic and positivist approaches have also been criticised. Firstly, comparison units in these approaches appear to be reduced to a “set of determined parameters” that only allow for quantitative analysis and very general research questions (Pinson, 2023, p. 236). Secondly, urban theory has been developed on the basis of a limited number of urban case studies, predominantly from European or American contexts. For example, urban models are based on the examples of New York or Chicago (Burgess et al., 1925), which are identified as “modern”, “developed” (Cox & Evenhuis, 2020, p. 429), or

“global” (Sassen, 1999). As a result, other cities from other cultural or geographical areas appear incomplete in comparison to these models, because they do not conform to established standards (McFarlane, 2010, p. 726). Furthermore, they appear to be of lesser value in terms of theoretical advancement, given that they are perceived as more “ordinary” (Robinson, 2006). This approach has been subjected to considerable criticism, with accusations of neo-colonialism and ethnocentrism (McFarlane & Robinson, 2012; Robinson, 2006; Roy, 2009). Many authors call for new methodological and theoretical approaches in urban studies to “reformat” urban theory while using comparisons and reflecting on comparison units (Le Galès & Robinson, 2023; Robinson, 2022). For example, there are calls for a more idiographic approach in the use of comparisons. Some authors argue that it is possible to use comparisons to identify and contrast the specificity of observed cases. For example, Gervais-Lambony (2003, p. 29ff) proposes the analysis of processes affecting different cities or places, with a view to demonstrating the distinctive characteristics of local specifics in relation to these processes. Pinson (2023, p. 239) argues that it is possible to practise what he terms “comparative monographs”. This approach would enable the precise and in-depth description of the different cases being compared, as well as the identification of local variations of general or global phenomena affecting spaces. For these authors, an idiographic approach to comparison does not preclude theoretical thinking or the construction and use of concepts. However, they emphasise the importance of rendering the thickness and precise description of comparison units, which may not necessarily be commensurable.

### **Consequences for geography education:**

It is essential to consider the perspective of the observer when evaluating comparisons, as nomothetic processes may give rise to validity concerns or ethical issues. Students may be confronted with problematic or invalid comparisons, and it is therefore necessary for them to develop a critique of the possible limits of comparisons. Therefore, when undertaking comparisons, it is important for students to develop their ability to reflect on the validity of their own comparisons and those they encounter. Furthermore, stereotypical examples or case studies may be present in geography education which may need to be reflected upon or deconstructed by the students.

### **2.1.8. Approaches on comparison as a whole process**

In the social sciences using international comparisons, comparison is often theorised and reflected upon as a whole process. In comparative education, Bereday (1964) and Hilker (1962) have proposed different steps that guide the process of comparison: description, interpretation, juxtaposition, and comparison. In the first step, researchers describe the comparison units. The second step involves the contexts of the units and their interpretation. The juxtaposition step establishes the comparison (a *tertium comparationis*). Finally, the comparison is realised and the results are reported. More recently, Pilz (2022) refined the process in the field of comparative vocational education: first, the researcher chooses the comparison units (countries), then proposes a research question. In a third step, the comparison variable is formulated and in a fourth step, the comparison units are compared according to this variable. Finally, the research question is answered. This process can become a research cycle if other comparison variables are then used in the further investigation (Pilz, 2022, p. 81). Ragin (1987) identifies three types of comparative research strategies in the social sciences: a variable-oriented comparison, which is mostly quantitative, a case-oriented comparison, which is frequently qualitative. Finally, he proposes a mixed comparative strategy, which he terms a “synthetic strategy”, in an attempt to combine both methods (Ragin, 1987, p. 85ff).

Other social sciences focus on the purposes of comparison processes, which allows for the formulation of typologies of types of comparison. In the field of history, Skocpol & Somers (1980) propose a typology of comparisons. This categorization distinguishes between comparisons that serve to demonstrate theory, those that contrast contexts, and those that infer macro-level structures and processes (Skocpol & Somers, 1980, p. 188). In the field of comparative politics, Lijphart formulates six different types of comparison, differentiated by their respective objectives. These include atheoretical case studies, interpretive case studies, hypothesis-generating case studies, theory-confirming case studies, theory-infirming case studies and deviant case studies (Lijphart, 1971, p. 691). Azarian also identifies the diachronic comparison as a possible comparative goal in the field of history (Azarian, 2011, p. 169).

A global theoretical approach to the steps to be taken in the process of comparison is absent from the field of geography. As previously indicated (see 2.1.5 and 2.1.6), comparison is a common practice. Comparative choices and results are subject to debate, while interpretations and policy advice are formulated. Theoretical and epistemological debates in geography revolve around research moves and practices involving comparison. Nevertheless, the theoretical discourse on comparison as a whole process is notably absent in the scientific community (Krehl & Weck, 2020, 1860). Rather, the focus is on the various comparative techniques (which variables, which scales, which indicators?). This can be analysed in two ways. Firstly,

comparison is sometimes implicitly used without questioning the possible limitations of the comparative process, as the different steps or elements are not considered either individually or as a whole. Secondly, it also shows the diversity, richness and abundance of different comparative possibilities and practices in geography.

Finally, reflection on the comparison processes, the limitations and potentialities of comparative moves are essential to comparative work. In the field of geography, Krehl & Weck (2020, pp. 1867-1871) define questions that should be at the outset of any comparative study in geography. These include the identification of theories and concepts, reflection on the generalisation ambitions, on case selection, on the definition of their objectives, and on the possible trade-offs realised during the process. These questions emphasise the importance of reflective comparison. Geographers need to be aware of the limitations of the comparative process and of the necessary arguments that underpin the whole comparison.

### **Consequences for geography education:**

There is no single approach to comparison as a method in geography; rather, there is a varied repertoire of comparative moves, which may include typology, inductive generalisations or “comparative monographs”. Students may encounter a variety of comparative techniques, functions, objectives, and challenges in geography, for instance, through different forms of comparison in textbooks or educational materials. In order to ascertain the extent to which such comparative moves or objectives are included in school materials and whether students are competent in comparing, research in geography education is necessary. Therefore, after describing the stakes associated with comparison in the scientific literature and in geography and their possible consequences for geography education in this section, the next section analyses how geography education research analyses comparison.

## **2.2 Comparison in geography education research: determination of research gaps and objectives of this dissertation**

A double paradox has already been identified: first, between the frequent use of comparative techniques and movements and the scarcity of theoretical approaches to comparison as a method in geography. Secondly, although comparison as a method is not much discussed, geographers argue about the elements, results and aims of comparison. Another paradox exists in geography education research: although comparison is mentioned in curricula and educational standards, theoretical approaches to comparison in geography education research



are scarce. Comparisons are present in international curricula and educational standards (2.2.1), but there are only few research approaches to comparison (2.2.2). Therefore, a first definition for comparison in geography education is proposed (2.2.3) and a model for the comparison method is selected (2.2.4). Furthermore, comparison is defined as a competency (2.2.5), as part of a broader scientific literacy (2.2.6) and of a possible international assessment (2.2.7). Finally, research gaps basing this dissertation are presented (2.2.8).

### **2.2.1. Comparisons in German, French and English curricula and educational standards**

The concept of comparison is referenced in educational curricula (e.g. in France: Ministère de l'Éducation Nationale, 2019, p. 2; in Germany: DGfG, 2017). In England and France, comparisons are often presented through case studies, which involve comparisons between specific cases and broader contexts. Other examples deal with international comparisons on a global scale (see 2.1.6) and related policy issues or decisions (e.g. Ministère de l'Éducation Nationale, 2019, p. 13; Ministerium für Schule und Weiterbildung & des Landes Nordrhein-Westfalen, 2014, p. 32). However, there is no analysis of how school materials, such as textbook tasks, implement these curricular orientations with regard to comparison.

In Germany, the verb *vergleichen* [to compare] is mentioned in the national educational standards (DGfG, 2020) as part of the second category of requirement areas (*Anforderungsbereiche*) which serve to structure and guide the formulation of educational tasks. In this system, which is inspired by Bloom's taxonomy (Bloom, 1956; Krathwohl, 2002), tasks are divided into three difficulty levels. At the first level, students merely reproduce knowledge, performing listing or describing tasks. In the second domain, students engage in knowledge reorganization, as evidenced by tasks such as classification. In the third domain, which encompasses problem-solving and evaluating tasks, students are required to explain, justify, evaluate, assess and take position (DGfG, 2020). One of the possible command verbs used in this differentiation in three domains is the verb "to compare". Nevertheless, the act of comparison is only described as a reorganisation task (DGfG, 2020, p. 32). In this conceptualisation of comparison, the act of comparison does not encompass the processes of reflection or the selection of comparison elements. This is problematic, since comparison is a considerably more intricate and challenging process than the mere reorganisation or classification of geographical content (Hieber et al., 2011). Moreover, there is no analysis of whether and how textbook tasks genuinely address this comparison complexity.

Comparison is a common feature of the European educational landscape. Nevertheless, despite the potential for insightful analysis on the subject of comparison in geography education, the available literature reveals only few direct investigations.

### **2.2.2. Comparison in geography education research: only few rare approaches**

In the previous section, it was demonstrated that comparison is a commonly mentioned educational tool in geography curricula. However, approaches from geography education research related to comparison are rare or date back some years. For example, comparison is identified as a mode of spatial thinking by Gersmehl & Gersmehl (2007). In their article, the authors identify eight fundamental modes of thinking “about conditions at places and connections among places” (Gersmehl & Gersmehl, 2007, p. 183) that young children should acquire. Comparison and analogy are referred to explicitly as “modes of spatial thinking”. Other modes of spatial thinking identified as fundamentals by these authors involve – implicitly – comparisons. For example, concepts such as region (defined as “a group of adjacent locations that have *similar* conditions or connections” (p.185), emphasis added), hierarchy (classifying spaces of “*different* sizes” (p.186), emphasis added)), or patterns and spatial associations (p. 187) imply comparisons (Gersmehl & Gersmehl, 2007). Consequently, comparison is regarded as a fundamental aspect of geographical thought by these authors. However, no analysis is provided on the most appropriate methodology for comparison, nor guidance on how comparison should be taught.

In the French and English-speaking literature on geography education, comparison is only rarely explicitly mentioned. However, comparison is implicitly present in the literature. Some works about case studies and examples refer indirectly to comparisons. For example, Leininger-Frézal et al. (2016) analyse exploratively the use of case studies in French higher education. Cases studies are frequently employed in theoretical classes on spatial planning, where they are used to illustrate theoretical concepts and to test the limits of theoretical models. They are also employed in inductive processes to build theoretical frameworks. In French secondary education, case studies are frequently presented at in the outset of learning sequences, in an active and constructivist approach. This enables the presentation of concepts and contexts on a local scale (i.e., a region), before contextualisation and generalisation at a global scale in a second phase. The process in French secondary education is therefore largely inductive (Leininger-Frézal, 2020; Mérenne-Schoumaker, 2017). In another study on case studies, Audigier (1993) critiques the inductive processes present in French school geography,

particularly with regard to comparison procedures. It is often the case that only one case is selected for comparison, and generalisations are made only with a change of scale without a thorough reflection on their validity. Audigier (1993) states, “It is extremely rare to come across systematic comparison practices to identify invariants that can be generalised, or to see students presented with material that strongly invalidates or nuances the generalisations observed...” (Audigier, 1993, pp. 55-56, translation by author). Although these reflections on case studies and their pedagogical use provide interesting insights into scalar comparison and how inductive processes are implemented, there is no analysis of the efficacy of these practices nor consideration of broader pedagogical possibilities for comparison processes. Only Alfieri et al. (2013) present results from different school subjects on the use of comparisons and case studies (primarily in the context of primary and adult education). Their analysis shows that inductive methods appear to yield superior learning outcomes compared to deductive procedures when teaching comparisons (Alfieri et al., 2013, p. 110).

Comparison in the German literature on geography education is mentioned in very general and short works, including geography education dictionaries (e.g. Köck & Stonjek, 2005, pp. 258-259 or Laske, 2013, pp. 284-286), general geography education textbooks (e.g. Jander et al., 1982; Kestler, 2015, pp. 224-226; Rinschede & Siegmund, 2022, pp. 228-230) and few practical propositions for geography classes (e.g. Kirchberg, 1986; Köck, 1981). To date, there has been no comprehensive research on the subject of comparison. In recent general works on geography education, including reflections on learning geographical methods or scientific literacy (Gryl et al., 2023; Nöthen & Schreiber, 2023), comparison is not presented as a specific method. Nevertheless, it is present in an article on “Othering” in geography education which allows for an indirect reflection on the possible limits of comparisons (Eberth & Lippert, 2023).

In dictionaries and textbooks where comparison is mentioned, although briefly, the objectives or methodology of the comparison are often not specified in detail or only partially. For instance, Schöpke presents comparison via a list of potential units, including geographical regions, models and real-world examples, material and data, and also different arguments (1981), pp. 30-32). Stroppe lists a variety of forms of comparison without differentiating between comparison objectives, units or variables. He considers that comparison can be spatial, historical, quantitative, qualitative, contrastive, related to analogies, to homologies, logical, or related to laws, implying causal and conditional relations (Stroppe, 1981, pp. 18-19). With regard to comparison objectives, inductive processes are the predominant approach (Laske, 2013, p. 285) while Rinschede & Siegmund identify comparison as being solely nomothetic (Rinschede & Siegmund, 2022, p. 228).

This research gap on comparison in geography education research is surprising, but this is not only the case for geography. In German education research, Pflugmacher (2018) also describes this absence of research into comparison processes, although comparison is a common practice in German classes. Following Pflugmacher's words, comparison is part of a common "didactic folklore" (Pflugmacher, 2018, p. 153). In this "folklore", comparison would only require application, thereby obviating the need for justification or reflection on its learning outcomes. In more recent years, the only article to reflect on comparison as a method for geography education was written by Wilcke and Budke (2019), in the first year of the project initiating and funding this dissertation.

### **2.2.3. Towards a definition for comparison in geography education**

Although the reasons why comparison is essential for geography education have been previously identified, there are only a few approaches to comparison and no general definition for comparison has been provided. The variety of possible comparison forms (such as a rhetorical task, a complex task requiring higher-order skills, or as part of a case study learning sequence) is not taken into account by those approaches. Furthermore, there is no analysis of the argumentative and reflective dimension of comparisons.

How comparison is a classical rhetorical task has already been analysed (see 2.1.2). However, further clarification is required to establish the links between comparison and argumentation in order to propose a definition for comparison in geography education. Argumentation is widely defined as a problem-solving process by which a disputed claim is to be refuted or confirmed by justifications (e.g. Bayer, 1999; Kienpointner, 1983; Kopperschmidt, 2000; Lueken, 2000). The structure of an argument consists of three main factors: the disputed claim, the evidence and the validity relationship between the evidence and the claim (Toulmin, 1996). Many characteristics of argumentation are also relevant for comparison. Both can be considered a process as well as a result (Eemeren & Grootendorst, 2004; Gutmann & Rathgeber, 2011). Both can have the meaning of knowledge justification as well as persuasion and play on a factual as well as on a normative level (Jiménez-Aleixandre & Erduran, 2007; Kienpointner, 1983).

The relationship between comparison and argumentation is two-way. Firstly, while arguing rhetorically, comparisons can be used as arguments (Kopperschmidt, 2011, 2018). Furthermore, comparisons are essential for evaluating the persuasive strength of two contrasting arguments or claims (Budke & Simon, 2021). For instance, in geography education, when advocating for the allocation of resources to a specific area (such as a former industrial region grappling with

unemployment and economic decline), it is essential to employ comparison results in a persuasive manner. This could entail utilising employment and poverty rates as evidence to substantiate the claim (i.e., that employment rates are lower in this region and poverty is on the rise). Additionally, it is crucial to reflect on how these specific results, when presented through variables such as employment or poverty rates, can effectively persuade others. Secondly, the comparison as a rhetorical task (*comparatio*) (see 2.1.2) can also only be performed using arguments to either sustain or refute a claim based on the comparison in question. For example, a claim that a region is poorer than others and thus requires funding necessitates the construction of arguments to demonstrate that poverty rates are a reliable indicator, that other indicators are less useful in sustaining the claim, and that poorer regions are the ones that should be funded. As a scientific process or tool for the acquisition of knowledge, comparison also necessitates argumentation. Firstly, argumentation and discourse are fundamental in the production of scientific knowledge (Osborne et al., 2004). Argumentation is at the heart of scientific discourses which produce scientific “facts” or “truths” based on argumentations, which in turn may base the production of new scientific “facts” contradicting or confirming former ones (Budke & Meyer, 2015; Luhmann, 1990). Therefore, while comparing, every step of the comparison process and comparison results must be justified and argued in the context of this scientific discourse, to be validly accepted and possibly refutable. Language use and argumentation are also fundamental for learning and thinking processes and play an important cognitive role (Jiménez-Aleixandre & Erduran, 2007).

A further aspect of comparison is the reflective dimension. Reflection on a comparison means to question the process and its results, while reflectivity means to reflect on one’s handling and actions within the context of the comparison (Gryl, 2012; Schneider, 2013). The results of a comparison must be justified and reflected upon, as must the consequences and limitations of a comparison. Finally, it is necessary to reflect on the manner in which one employs comparison in the learning process and on one’s own approach to comparison.

Wilcke and Budke (2019) are the only authors to propose a definition for comparison in geography education in the first article from the project that initiated this dissertation (see Box 1).

Comparison is a reflective and argumentative process. Based on a geographical question, a number of units are selected, whose similarities and differences are identified along determined variables in order to work out interrelations. Based on this, justified explanations are formulated
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to answer a specific question, or further questions are raised, which need to be considered to develop a final answer.

Box 1: Definition for comparison, Wilcke & Budke, 2019, p. 4.

Precising this definition, they emphasise the significance of the initial question and demonstrate how reflection, argumentation and problem-solving are fundamental to comparison processes. The article illustrates, through the example of the distribution of refugees in Europe, how comparison could ideally be developed in a step-by-step manner. This represents a preliminary foundation upon which to define comparison as a method to be employed in geography education. However, in light of former analyses of scientific comparison (see 2.1), it appears that certain elements are lacking in the definition, such as the significance of data selection and the variation between potential comparison objectives and forms.

Having conducted a comprehensive analysis of both scientific literature on comparison in geography and in geography education, I now seek to propose a definition for comparison that allows for the diversity of comparison objectives, practices and choices. Comparison is not merely a psychological process, an instrument for acquiring knowledge, or a set of contested scientific methods. Rather, I argue here that it can be considered as an act. In light of the aforementioned considerations, I propose the following definition (see Box 2).

To compare is the reflective and argumentative act of selecting and examining comparison units (i.e. observations or cases), along selected variables (i.e. criteria or aspects), using selected data to assess similarities and/or differences and arrive at an answer to a specific chosen geographical question.

In this definition, the act of comparison is contingent upon the following conditions:

- The presence of a comparing subject who employs comparison in a deliberate, argumentative and reflexive manner.
- The existence of conscious intentions and objectives (e.g. nomothetic or idiographic) related to the comparison.
- The utilisation of informed and justified choices regarding data collection, comparison units, variables and their juxtaposition and weighting in accordance with comparison objectives.
- The demonstration of critical awareness and reflection on the limitations of the performed comparison.

- The recognition of the flexibility and modularity of comparison processes or moves, whereby comparison questions and/or comparison objectives may be defined or refined following the consideration of comparison elements.

Box 2: Definition for comparison in geography education. Own elaboration.

#### **2.2.4. Towards a model for the comparison method as a tool for geography education**

In order to teach comparison in geography education, it is necessary to model the act of comparison in specific steps that correspond to the task or teaching sequence steps. This is also necessary since the variety of comparative moves needs to be reduced or transposed in a model to help students perform them. This model for comparison may therefore serve as a possible basis for the development of a scaffold to teach the comparison method in geography classes. Although comparison is not a prominent topic in geography education research, a few methodological contributions in university textbooks and articles on comparison define comparison steps and propose a didactically reduced methodology for classroom situations. In order to identify a suitable model for implementation in geography classes, Table 1 presents a synthesis of the aforementioned propositions for a comparison method.

<b>Authors, education research area (date), type of comparison</b>	<b>Eichberg, general education research (1972): homological comparison</b>	<b>Eichberg, general education research (1972): analogical comparison</b>	<b>Silver, general education research (2010): compare and contrast task</b>	<b>Schreiber, history (2005): general comparison</b>	<b>Stroppe, geography, (1981): general comparison</b>	<b>Kirchberg, geography (1986): case comparison</b>	<b>Kestler, geography (2015): general comparison</b>	<b>Wilcke &amp; Budke, geography (2019): general comparison</b>	
<b>Comparison steps</b>	Observation		Description (selection of comparison objectives, materials, variables)	Clarification about the objective of the comparison	Visualization of the objects of comparison			Developing a geographical question	Argumentation and reflection
				Selection of comparison units	Identification of suitable points of comparison	Selection of comparison units and materials	Selection of comparison units and objective	Determination of comparison units, retrieving and analysing information	
				Selection of comparison variables		Decision on comparison variables and objectives	Selection of comparison variables	Determination of comparison variables, retrieving and analysing information	



				Selection of comparison materials					
	Analysis	Analysis from <i>signifié</i> or <i>signifiant</i> (analogy elements)		Analysis of materials					
	Comparison	Comparison	Comparison		Juxtaposition Comparative phase	Comparison: Juxtaposition and analysis	Comparison: Juxtaposition and analysis	Juxtaposition	
	Record of the results and interpretation	Interpretation of results	Conclusion (reflection and weighting of results)	Presentation of results (and results' conditions)	Evaluation of the results of the comparison	Evaluation of results	Evaluation of results and explanation	Weighting of variables, development of connections between the units and deriving explanations	
			Application, synthesis	Analysis and reflection of comparison process and results				Evaluation of results and answering of the question	

Table 1: Methodological steps for comparison in education. Own contribution after Eichberg (1972, p. 80), Silver (2010, p. 31), Schreiber (2005, p. 10-11), Stroppe (1981, p. 22), Kirchberg (1986, p. 10), Kestler (2015, p. 225), Wilcke & Budke (2019, p. 7).

Eichberg (1972) examines different learning sequences in different school subjects involving comparisons. Homological and analogical comparisons comprise four distinct stages. These include the observation and analysis of the comparison elements, the comparison itself, and finally, an analysis of the resulting data. Although this method differentiates between homological and analogical comparisons, there is no reflected selection of comparison elements or data to realise the comparison. This is, however, a necessary requirement (2.2.3) if comparison is taught as a scientific method. It is essential that students are able to autonomously select different comparison units, variables, objectives and materials to conduct the comparison. Such choices must be informed, justified and argued. All other approaches present the selection of comparison elements as the initial step in the comparison process. While Wilcke & Budke (2019) do not mention the selection of comparison material or data to build the comparison, this is also the case of Stroppe (1981) and Kestler (2015). Silver (2010) does not mention the comparison units. The determination of the comparison objectives is to be carried out at the outset of the comparison process for Silver (2010), Schreiber (2005), Wilcke & Budke (2019), whereas other authors (Kirchberg, 1986; Stroppe, 1981) stipulate that the development of the comparison objective is contingent upon the previous selection of other comparison elements. All authors include a “comparison” step, namely the juxtaposition of comparison elements, with the exception of Schreiber (2005). Finally, the evaluation and interpretation of results are also present in all approaches. However, only Silver (2010), Schreiber (2005) and Wilcke & Budke (2019) include either the weighting of variables and/or reflection on obtained results.

Ultimately, Wilcke & Budke (2019) propose that argumentation and reflection should be incorporated as a fundamental component of the comparison process, occurring at each stage of the process. Their model and method are more aligned with the requirements of our former definition (see 2.2.3) than the others, since this definition identifies argumentation, critical thinking and reflexivity as being at the core of comparison processes. Although this model appears to be theoretically sound and consistent with the criteria for scientific comparison, its efficacy as a potential teaching tool or as a scaffold (Vygotsky, 1978) has not been evaluated. Additionally, the model does not account for potential variations in the comparison process. It does not consider the possible objectives of the comparison or how the comparison steps might vary. However, this is the only model which goes beyond the simple description of a mechanical process which would be the comparison and instead incorporates argumentation as an intrinsic component of the comparison process. Based on this, further research gaps can be considered: we don't know to what extent current tasks foster different comparison objectives or the use of the model's comparison steps. Similarly, there is limited understanding of how students perform

when engaged in comparison tasks and the specific scaffolds that could be developed to support more effective comparison.

### 2.2.5. Comparison as a competency

In this section, I propose that comparison should be further considered as a competency in geography education. The concept of competency is a fundamental element of European educational systems and education policies. The definition of competency varies very much depending on the context, which makes of competency a rather “fuzzy” concept (Le Deist & Winterton, 2005, p, 29). The OECD defines the concept of competency as englobing “knowledge, skills, attitudes and values to meet complex demands” of today’s world (OECD, 2018); the European Commission also defines key competencies as a “combination of knowledge, skills and attitudes” which are developed “throughout life, through formal, non-formal and informal learning in different environments” (Directorate-General for Education, Youth, Sport and Culture (European Commission), 2019, p. 5). The concept of competency was initially defined in vocational education and management studies with the objective of assessing workforce development and performance, and of defining standards to be achieved (Le Deist & Winterton, 2005). In German education research, the concept of competency is discussed after Weinert who defines competencies as “cognitive abilities and dispositions available or learnt by individuals to solve specific problems, as well as the associated motivational, volitional and social abilities and willingness to successfully and responsibly implement these solutions in variable situations” (Weinert, 2001, p. 27, translation by author). In French-speaking countries, the *compétence* concept is often defined in educational contexts while associating it with *capacité* [ability, translation by author] which is an operational and simple part of a broader competency. A common definition was proposed by Tardif (2006, p. 22): “a competency is a complex know-how based on the effective mobilisation and combination of a variety of internal and external resources within a family of situations” (cited by Tardif, 2017, p. 20, translation by author). In Tardif’s definition, a competency is complex: it is not merely the aggregation of smaller competency elements; rather, it represents a superior construct that goes beyond its dimensions. All definitions tend to state competencies as broader than being only cognitive or only present in the educational system. Competencies are related to real-life situations (Koeppen et al., 2008, p. 62). However, all definitions also insist that competencies apply to specific situations and contexts.

In light of the definition of comparison (see 2.2.3), the comparison method from Wilcke & Budke (2019, see 2.2.4) and the various definitions for competency, this dissertation posits that comparison can be defined as a competency. Comparisons are not limited to geographical contexts and are not solely relevant in educational systems (see 2.1). They are connected to real-life problems or situations (for example, the allocation of financial resources from the EU to specific regions or the discussion of spatial inequalities): to compare is a general and complex competency and not a simple *capacité*.

Therefore, in accordance with Weinert's and Tardif's definitions, comparison competency can be defined as follows (see Box 3).

Comparison competency is complex and supposes that students dispose of cognitive abilities and dispositions to perform and evaluate comparisons, and that students show the associated motivational, volitional and social abilities and willingness to successfully and responsibly implement these comparisons in variable situations.

Box 3: Definition for comparison competency. Own definition after Simon & Budke, 2021; Tardif, 2017; Weinert, 2001.

In numerous different position papers and policy documents, competencies are enumerated and defined to inform political and educational agendas and serve as desired objectives in international measurements of educational outcomes, both in individual and collective assessments. In European curricula, as well as in numerous other performance-oriented educational policies and documents (Glaesser, 2019), competencies are conceptual and operational constructs used to help define educational objectives. In order to assess geographical competencies, researchers develop competency models which describe the dimensions and levels within competencies (Klieme & Leutner, 2006). Competency structure models differentiate between the elements that compose and build competencies, whereas competency level models differentiate between the possible levels that students may attain while acquiring the competency. It is possible to either formulate theoretically competency models in a deductive way (for example, in the case of spatial citizenship (Schulze et al., 2015)) or to validate competency models while empirically and quantitatively measuring different levels within students' performances (Mehren & Rempfler, 2022). Another method of developing competency models is to identify the steps involved in the acquisition of competencies. Despite the existence of numerous formulations of geographical competencies and research on the assessment of these competencies in contemporary geography education

research, to date, there is no competency model for comparison in geography education in either of these possible formulations of competency models. A competency model for comparison in scientific processes can be found in biology science (Wellnitz & Mayer, 2013), which encompasses the processes of observation, comparison and experimentation. However, this model only refers to comparison as a technique for classifying biological systems and building typologies. This implies that there is no established competency model for comparison in geography education, nor is there an evaluation of students' competency and performance while comparing. Furthermore, there are no existing tools or scaffolds to assist students in performing comparisons and developing their comparison competency. As a consequence, I argue that a competency model should be developed which defines comparison competency dimensions and sets out the levels involved.

#### **2.2.6. Comparison competency as part of a broader scientific literacy**

*Scientific literacy*, the capacity to comprehend and critically analyse scientific issues, has long been recognised as a crucial stake internationally and politically (OECD, 2019b; Roberts, 2007) and as a key competency (Rychen & Salganik, 2001, p. 16). Osborne (2023, p. 789) identifies scientific literacy as the ability to respond to the following questions: “What exists? What causes this event/phenomenon to happen? How do we know? How do we talk about this phenomenon/explanation? What can we do with this knowledge?” Scientific literacy implies, thus, to know scientific methods and scientifically established facts. It encompasses not only the acquisition of content knowledge but also an understanding of scientific procedures, debates, and limitations. Furthermore, Osborne (2023, p. 789) specifies that scientific literacy entails the ability to comprehend how scientists arrive at answers to these questions, while using “styles of reasoning” which include inductive and deductive processes, and epistemic knowledge involving for example different research steps, engagement in argument and identification of variables. The PISA 2018 Science Framework from the OECD divides scientific literacy in three competencies: “explaining phenomena scientifically, evaluating and designing scientific enquiry, and interpreting data and evidence scientifically” (OECD, 2019, p. 99). A last dimension of scientific literacy is the ability to understand, analyse and evaluate scientific discourses around scientific facts and knowledge (Norris & Phillips, 2003; Osborne, 2023; Postman & Weingartner, 1971).

Since to compare is one of the repertoire of scientific methods and “moves”, comparison competency can be analysed as a part of scientific literacy. For example, demonstrating proficiency in comparison competency can facilitate the ability to “explain phenomena

scientifically” (OECD, 2019, p. 101). For instance, to compare can help understand geographical process such as urbanisation or gentrification (i.e. utilising scientific concepts in a deductive manner). Comparison competency is also related to the competency “evaluate and design scientific enquiry” (OECD, 2019, p. 101). This entails selecting comparison elements and evaluating the selection reflexively, as well as evaluating the results of comparisons conducted by others. Finally, to compare also implies to “interpret data and evidence scientifically” (OECD, 2019, p. 102), which may be achieved through the creation of maps or diagrams and the discussion of the results obtained.

All these elements should be fostered via interventions or in curricula to enhance scientific literacy, as research has long stated. In geography education research, Chang and Kidman (2019, p. 2) also identify the necessity to enhance the teaching of geographical methods and a few approaches or interventions are present in geography education research. For example, experiences in physical geography (Otto et al., 2010), excursions and fieldwork (Rinschede & Siegmund, 2022, p. 237) are presented as a means of reproducing scientific practices with students and of learning them. This is also the case in inquiry-based learning approaches (Reverdy, 2013; Roberts, 2003; Weiss & Gohrbandt, 2018), which aim to reproduce scientific inquiry in the classroom through the students’ autonomous reproduction of scientific steps. However, in human geography, such approaches are rather scarce (Weiss & Gohrbandt, 2018). Moreover, comparison is not often mentioned in geography education research, either as a scientific method, or as a common way to explain phenomena geographically or to design geographical enquiry (see 2.2.2). Until now, the research focus was not on comparison as a geographical subject, as a scientific method or as a discourse, or as a competency being part of a broader scientific literacy. Only Kuisma & Nokelainen (2018) included comparison as a step in the inquiry process as a teaching method in geography education. However, in their work, comparison is only present in a learning sequence and in tests as a closed task, without being a specific method that is subject to reflection.

### **2.2.7. Comparison competency in international comparisons and assessments**

Since the 2000s, international comparisons in educational research have frequently been driven by the objective of “measuring the ‘other’” (Nóvoa & Yariv-Mashal, 2006, p. 4). This is “linked to a global climate of intense economic competition and a growing belief in the key role of education in the endowment of marginal advantage” (Nóvoa & Yariv-Mashal, 2006, p. 4). Those involved in politics and education at the decision-making level advocate for the use of

international indicators, while researchers also seek to develop such indicators or propose subsequent curricula. The development of standardised assessment tools facilitates the creation of international large-scale assessments (OECD, 2019b), which permit comparisons to be made both within and between countries. For example, the PISA (Program for International Student Assessment) studies aim to measure internationally students' outcomes from different countries. The consequences of these different standardised psychometric assessments are diverse. Firstly, educational systems are compared internationally in order to identify the most and least effective systems and to analyse their performance (Barrenechea et al., 2023; Schleicher, 2012; Sellar & Lingard, 2014). Secondly, temporal comparisons and the development of educational systems can be quantified through repeated testing. Finally, the results of these assessments can be used to inform and influence educational policies. The field of global education policy is becoming increasingly globalised, with the emergence of new actors influencing political decisions while participating in the governance of educational systems at the system level (for example, the private sector or international organisations) (Barrenechea et al., 2023; Lingard & Rawolle, 2011).

Although informative and useful, international standardised assessments and subsequent reports have also been the subject of criticism. Following a report from the McKinsey company (Mourshed et al., 2010) which outlines straightforward solutions towards educational improvement as a kind of recipe, other authors highlight that historical, social and political factors also influence educational outcomes, policies and possible improvements (Auld & Morris, 2016; Barrenechea et al., 2023). In another article, Nóvoa and Yariv-Mashal also call for a more balanced approach to historical comparisons, criticising the lack of social and structural analysis in some comparative works that insist on the “comparability” of countries and on governance (Nóvoa & Yariv-Mashal, 2006).

In geography education research, various researchers call for a more comprehensive assessment of geographical competencies and emphasise the necessity of integrating geography into international assessments (Bourke & Lane, 2017; Bourke & Mills, 2022; Lane & Bourke, 2019). Although there are international comparisons for scientific literacy in the context of international assessment (OECD, 2019b, 2019a), there is neither data on students' geographical skills, nor on their comparison competency. Furthermore, there is no validated or reliable assessment tool to evaluate comparison competency or reflection on how students from different countries may develop different strategies while performing comparisons.

### 2.2.8. Conclusions and research gaps basing this dissertation

The following conclusions can be drawn following the first theoretical section. Firstly, it can be posited that children use comparison as a fundamental cognitive activity, to make sense of their environment and develop spatial orientation. Research in psychology has demonstrated that children's ability to compare increases with age and proficiency in the subject (see 2.1.1). This suggests that geography education could build on this. Secondly, comparison in its rhetorical task form is not absent from European school systems (see 2.1.2) and task cultures. Indeed, comparisons are powerful tools to reason, argue and convince others (see 2.2.4 and 2.2.5). It is therefore of great importance to train students in the art of comparison, in order to prevent them from being manipulated. Thirdly, comparison is a fundamental instrument for the acquisition of knowledge, and subsequently, a method employed in modern science (see 2.1.3 and 2.1.4). Even early social scientists identified comparison as an important method alongside experiment to base and legitimate social science. Consequently, comparison has been and continues to be a means of formulating scientific concepts or rules. It is fundamental to the very essence of scientific processes. Geographers use comparison to make sense of the diversity and complexity of the world through case studies, typologies, and generalisations. Comparisons represent a powerful tool for the generalisation of concepts and the construction of theoretical frameworks. By generalising and formulating spatial concepts that are common to several areas, comparisons help to overcome the former *Länderkunde*, which was a geography that studied areas one after the other in a catalogue approach, without establishing links between them. These fundamental aspects of comparison are indispensable to geographical thought and the formation of geographical knowledge (see 2.1.5). Consequently, comparison must be an integral component of curricula and geography education and systematically trained. However, comparisons are complex and diverse. They vary in their forms, for example, between analogy or homology. There is not a single comparison method, since comparison is used differently using different comparative moves, depending on the comparison objective, in a nomothetic or an idiographic approach. For example, in the inductive approach, cases can be compared in order to construct rules, or they can be compared with theoretical models in order to test theories in a deductive process. Furthermore, comparison can be employed to construct typologies, either in conjunction with case description or as a preliminary step prior to the process of generalisation. In the field of geography, scalar comparisons are also of great importance (see 2.1.6). In geography, comparisons allow to analyse, for example, spatial inequalities. Comparisons are represented in different media such as maps, which necessitates the careful



selection of relevant and reliable data, the specification of variables and units or scales. Such comparisons are fundamental to the decision-making process, for instance, in the attempt to address spatial inequalities. Consequently, comparisons represent a potential preliminary step in the formation of arguments, which may be either civic or political in nature. They may also serve as the foundation for decisions and actions. This implies that they are not neutral instruments and can be manipulated or rearranged to serve political or specific objectives. The ability to produce or understand a comparison necessarily entails the capacity to reflect on this eventuality (see 2.1.6). This should be a fundamental aspect of geography education. Consequently, the nature of the comparison is contingent upon the geographer's intentions (e.g., to derive a generalising law through induction or to classify) and choices (e.g., the specific variable to be tested through deduction). These choices and intentions are conditions to the comparison and influence the choice of comparative elements and the outcome of the comparison. It is also important to consider the position of the person comparing in order to mitigate the risk of ethnocentrism. Comparison is a method that has been the subject of much debate within the social sciences and geography, with numerous scientific discourses on comparison (see 2.1.5 and 2.1.7). This has implications for the scientific practices surrounding comparisons. It is crucial to be aware of the theoretical implications of comparisons if we are to teach scientific literacy about geographical methods. A review of the state of research in education reveals that although comparison is a fundamental concept, present in school curricula and educational standards, it is not a prominent area of research in geography education (see 2.2.1, 2.2.2). Furthermore, there are no international assessments of comparison competency. On the basis of these elements, a definition for comparison was provided (see 2.2.3) and models for the comparison method were analysed (see 2.2.4). Furthermore, comparison could be defined as a competency (see 2.2.5).

However, research gaps were identified which will guide the dissertation's work:

- 1) Firstly, there is a need for more theoretical and empirical research into the manner in which comparison is present in school material to identify possible objectives of comparison within the educational context in different countries.
- 2) Secondly, comparison needs to be modelled as a competency to be able to enhance it. This can also help assess the possible performance of comparison tasks as present in international textbooks in terms of possible competency development.

- 3) Thirdly, there is a need for an assessment tool for comparison competency and for an assessment of future teachers' and secondary school students' comparison competencies.
- 4) Fourthly, there is a requirement for teaching tools or scaffolds for comparison competency development. To date, there is no intervention on the use of the comparison method as a tool to learn comparison in geography education.
- 5) Fifthly, there are potential obstacles to the development of comparison competency and it is unclear how students develop comparison strategies and may encounter difficulties when confronted with complex comparison tasks.

Having presented the theoretical background of this dissertation, the following chapter elucidates the methodological and comparative approach.

### **3. Methodological approach**

To model comparison competency in geography education, develop a competency assessment, assess students' comparison competency and test pedagogical tools and scaffolds to enhance comparison competency, the work in this dissertation was divided into three phases and five studies (see Figure 4).



Figure 4: Dissertation's phases, studies, research questions and methods. Own elaboration.

### 3.1 Phase 1: Theoretical work and analysis of current situation of comparison tasks in geography textbooks

The first phase of the dissertation consisted of a theoretical work and of a first empirical analysis of comparison tasks in geography textbooks from Germany, France and England. Textbooks are very important in the preparation and implementation of learning sequences (Matthes & Schütze, 2011), and are the result of curricular orientations (Lee & Catling, 2017), which makes them interesting educational media to analyse. Study 1 proposed a typology and analysed textbook tasks' comparison objectives (3.1.1), while Study 2 constructed a competency model for comparison competency and investigated how comparison tasks promote comparison competency (3.1.2).

### **3.1.1. Study 1: The objectives and uses of comparisons in geography textbooks: results of an international comparative analysis.**

As previously stated, there is a necessity for an investigation into the various comparison objectives in geography education and an examination of the current state of comparison in existing educational materials. Therefore, Study 1 addressed both theoretical and empirical research questions. Primarily, it sought to construct a typology of textbook tasks in geography education. Secondly, an analysis was conducted of textbook tasks from Germany, England and France with the objective of evaluating the manner in which textbooks integrate comparison tasks and of categorising these tasks in the typology. Accordingly, the following research questions were addressed:

- How can we categorise the objectives of comparison tasks in geography education and establish a typology?
- To what extent do textbooks from the three countries include comparison tasks, and to what categories do these comparison tasks belong?

To achieve this, 20 textbooks containing 10,681 tasks (411 tasks in German, 209 in French and 361 in English books) were analysed. While selecting the textbooks, local contexts were considered which influence on the textbook selection as well (more precisely, our studies referred to three countries, but the curricula concerned and used in the books studied are only valid nationally for France. The selected English textbooks are only valid for England and not for the whole of the United Kingdom, while the selected German textbooks are only valid for North Rhine-Westphalia and Berlin-Brandenburg). The selection of textbooks was based on the objective to build a commensurable corpus of comparison tasks allowing for “thick” descriptions (Candea, 2018, p. 349). The aim was to avoid creating completely different units, while also ensuring that the units were not completely identical.

Of the 10,681 tasks identified, 981 were classified as comparison tasks. A comparison task was defined as a task that involved one or more subtasks, in which students engaged in the production or reception of a comparison, and in which the comparison units were contrasted according to one or more variables. Firstly, a typology of the objectives of comparison tasks was constructed through an inductive-deductive qualitative content analysis (Mayring, 2014). Comparison was present via a hypothetico-deductive analysis of the comparison tasks according to their proximity to the types of comparison present in the scientific literature, and via a generalisation by induction based on the corpus of comparison tasks. The construction of a typology, one of the classic forms of scientific comparison (see 2.1), was here a prerequisite to the classification of tasks into the types concerned. The classification was refined and its reliability tested via the calculation of Kappa's coefficient (0.66), with three judges classifying the comparison tasks into the categories. Secondly, the quantitative analysis of the tasks was conducted during the classification process, which involved the typology and other variables, such as country, age of students, location of the task in the chapter, and the presence of scalar comparison. Descriptive statistics were employed to analyse the obtained classifications, and a Pearson Chi-Square Test was conducted to assess the independence between variables.

### **3.1.2. Study 2: How geography textbooks tasks promote comparison competency – an international analysis.**

Another research gap identified the need to model comparison as a competency in order to enhance it. This would also assist in evaluating the potential efficacy of comparison tasks as presented in international textbooks in terms of their capacity to facilitate competency development. To address this issue, the research questions for Study 2 built upon the findings of Study 1 and were as follows:

- How can we model comparison competency?
- To what extent do textbooks enable the development of comparison competencies: how many tasks address comparison and what competency levels are they supposed to enhance?
- Can we identify differences between countries with regard to the promotion of comparison competency in textbook tasks?

In order to address these questions, a model for comparison competency was first constructed on the basis of the model for the comparison method proposed by Wilcke & Budke (2019, p.4) and on the first article of this dissertation (Simon et al., 2020). This allowed to define four

dimensions of comparison competency, with four levels of competency in each of the dimensions. The model was then tested on the sample of 981 comparison tasks from Study 1 using 20 textbooks from Germany, England and France. All tasks were classified according to the four dimensions of comparison competency using deductive content analysis (Mayring, 2014) in order to assess the extent to which textbook tasks facilitate the enhancement of comparison competency. The results were analysed using descriptive statistics, which served to validate the theoretical competency model. Finally, the tasks were differentiated according to country to explore the specific characteristics of textbook cultures in different countries. The findings of these two studies (Simon et al., 2020; Simon & Budke, 2020, see also Budke & Simon, 2021; Simon & Budke, 2021) provided valuable guidance for the dissertation's development phase.

### **3.2 Phase 2: Development phase: digital learning unit and assessment test for comparison competency**

In phase 2, an educational tool was developed in the form of a digital learning unit that is available as an Open Educational Resource (OER)<sup>2</sup>. The objective of this digital learning unit was to develop students' comparison competency using the subject of past and current human migration, utilising the results from the CRC 806. The digital learning unit, available in French, German and English, employs authentic documents and data, interviews and maps from scientists, which have been didactically transposed to allow students to autonomously select a subject and explore and compare the subjects of migration reasons, obstacles to migration, migration routes and research on migration in the past and today (Budke, Simon, et al., 2021; Schäbitz et al., 2023). In order to analyse the results of students who have been taught using this digital learning unit, an assessment tool for comparison competency was developed and tested in Study 3 (3.2.1). This was conducted in accordance with the comparison competency model developed in Study 2 (Simon & Budke, 2024b).

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<sup>2</sup> The OER was developed within the DiGeo Project financed by the German Federal Ministry for Education and Research. The digital learning unit can be consulted at following links:  
In German: [https://www.ilias.uni-koeln.de/ilias/goto\\_uk\\_lm\\_4325913.html](https://www.ilias.uni-koeln.de/ilias/goto_uk_lm_4325913.html).  
In English: [https://www.ilias.uni-koeln.de/ilias/goto\\_uk\\_lm\\_4911773.html](https://www.ilias.uni-koeln.de/ilias/goto_uk_lm_4911773.html).  
In French: [https://www.ilias.uni-koeln.de/ilias/goto\\_uk\\_lm\\_4391846.html](https://www.ilias.uni-koeln.de/ilias/goto_uk_lm_4391846.html).

### **3.2.1. Study 3: Students' comparison competencies in geography: results from an explorative assessment study**

One identified research gap is the absence of an assessment of students' comparison competency and an evaluation of students' difficulties when comparing in geography classes. Consequently, Study 3 was designed to develop and validate an assessment instrument for comparison competency, based on the competency model developed in Study 2.

Research questions from Study 3 were as follows:

- How can the comparison competencies of geography students be validly assessed on the basis of the comparison competency model?
- How competent are geography students when asked to write an essay to solve a comparison task?
- How are the writing strategies they use related to their comparison competency?

In order to achieve this objective, a comparative task on the subject of migration was devised, which permits students to provide diverse, complex and open responses, based on the use of authentic migrant testimonies. The efficacy of the task was evaluated with a sample of 17 university students prospective teachers at the Institute for Geography Education, University of Cologne, Germany. Subsequently, an assessment instrument was constructed. The initial section of the assessment was based on the competency model from Study 2 (Simon & Budke, 2020) and was subject to further refinement as a result of the grading of tests, which was conducted on a repeated basis. The second component of the assessment tool was designed to evaluate students' writing strategies for structuring their texts. The criteria for the assessment were constructed via an inductive analysis of the tests, but also on the basis of the scientific literature on discourse analysis and literacy research (Englert & Hiebert, 1984; Hammann & Stevens, 2003; Spivey, 1991). The assessment tool was then evaluated for its validity and reliability via a calculation of inter-rater reliability for the first part of the test (obtaining a Kappa coefficient of 0.72) and intra-rater reliability for the text structures' assessment part (obtaining a Kappa coefficient of 0.922). Finally, descriptive analyses were carried out to analyse exploratively students' competency while comparing and correlations were calculated to assess the links between students' scores in relation to comparison competency and in text structuration.

Both digital learning unit and assessment tool for comparison competency were then used in Phase 3 of the dissertation in an intervention with secondary students.

### **3.3 Phase 3: Intervention phase**

In Phase 3, finally, Studies 4 (3.3.1) and 5 (3.3.2) were organised in a mixed-methods approach with embedded design (Creswell & Plano Clark, 2017) to answer the need to assess the comparison competency of secondary students and to test teaching tools and scaffolds to facilitate the development of comparison competency.

#### **3.3.1. Study 4: An intervention study: teaching the comparison method to enhance secondary students' comparison competency**

In the primary quantitative study (Study 4), an intervention utilising the digital learning unit and the comparison method as a scaffold was conducted with secondary students from France and Germany. The study assessed the comparison competency of secondary students and aimed to validate the use of the comparison method as a teaching tool that enhances comparison competency (Simon & Budke, 2024a). Study 4 addressed the following research questions:

- How competent are secondary students in the different dimensions of comparison competency?
- To what extent does the use of the comparison method applied in the intervention have an impact on students' comparison competency?

In this study, a quasi-experimental intervention with a pre- and post-test control group design was used after recruiting 83 secondary German (23) and French (60) students (control group: 39 students; experimental group: 44 students). The selection of the comparison units (two German and two French classes) was initially based on convenience (proximity of researcher to former French colleagues). However, socio-demographical variables were also considered in order to choose the German school as a “commensurable” counterpart to the French school. This involved factors such as age, school results, previous geographical education, and the enrolment of the experimental group in specialised classes for geography. Additionally, the geographical location of the school was taken into account, with the inclusion of a school situated in an urban area with a high population density and a relatively affluent population.

In Study 4, while French and German students were compared in Study 5, the focus was on the control and experimental groups. In order to ensure the homogeneity of the two groups being compared, a t-test must be employed. Both groups of students were required to complete a pre-test based on the same task as used in Study 3. The students were then assessed on their comparison competency using the assessment tool that was also developed in Study 3. This



allowed for the initial assessment of comparison competency in secondary students, with reliability ensured through the calculation of inter- and intra-rater reliability (Kappa coefficient of 0.837 on German and 0.905 on French tests). Subsequently, students in the experimental group were taught the comparison method through an intervention utilising a digital learning unit published as an open educational resource (OER) on the subject of past and recent migration (see Figure 5).

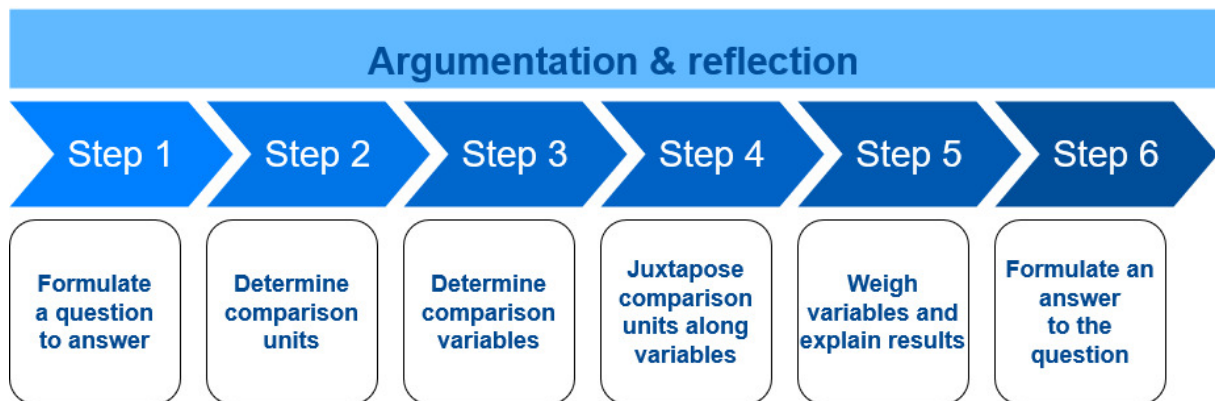


Figure 5: The comparison method as used in the intervention (Phase 3). Own elaboration after Wilcke & Budke, 2019.

The intervention employed a “mixed” design (Cavagnetto, 2010), whereby students initially learned the method explicitly before being placed in a research situation. Once the students were acquainted with the comparison method (see Appendix 1), they had then to perform a comparison using the materials available within the digital learning unit (see Appendix 2). The students were permitted to select the comparison question and variables at their discretion. The students were guided by a task sheet which explicitly applies the comparison method and all its steps (see Figure 5), and they were required to write a text in which they summarised their findings. This enabled the assessment of the use of the comparison method during the intervention in a second, shorter assessment. Finally, group discussions were organised (see Study 5). Descriptive statistics were employed to assess students’ comparison competency before and after the intervention, with the use of pre- and post-tests. The competency and progress of the groups between the pre- and post-tests were compared using t-tests and a one-way analysis of covariance (ANCOVA), with the pre-tests used as a covariate. The results of the assessment of the use of the comparison method were correlated with the progress between the pre- and post-tests in order to assess the effectiveness of the comparison method used as a

scaffold during the intervention. Finally, a Welch's t-test was employed to compare the experimental group's post-test results with those of university students from Study 3.

### **3.3.2. Study 5: German and French students' strategies while performing geographical comparisons in a group task setting**

Finally, it is necessary to gain an understanding of the processes by which comparison competency can be developed, the potential obstacles to such development, and the most effective strategies for students. The embedded qualitative Study 5 (Simon & Budke, 2023) allowed for an exploration of group discussions during the intervention, thereby providing insight into the manner in which students develop comparison competency. Study 5 explored the following research questions:

- What student groups' action-guiding orientations can be reconstructed while they perform open comparison tasks?
- What strategies do German and French students adopt to solve argumentative and collaborative comparison tasks, and how do these strategies relate to individual performance regarding comparison competency during the intervention?
- To which extent can we identify different action-guiding orientations or strategies between French and German students?

In this study, the documentary method (Bohnsack, 2013, 2014; Bohnsack et al., 2010) and qualitative content analysis (Mayring, 2014) were used to reconstruct students's action-guiding orientations during groups discussions, which were led and recorded in the final phase of the intervention (see Study 4). The objective of this study was to examine the contribution of group discussions to the development of comparison competency during the intervention. The group discussions were organised in two phases using the "group puzzle" method. In the first phase of regrouping, students who had studied the same subject during the individual work phase of the intervention were reassembled; in the second phase, students working in different subjects were grouped. The students had to collectively solve a general comparative task that does not require a specific or correct answer and justify their response. The transcriptions of the discussions were realised using MAXQDA and analysed qualitatively using the documentary method (Bohnsack, 2013, 2014; Bohnsack et al., 2010) and qualitative content analysis (Mayring, 2014). The collective orientations, strategies and utilisation of the comparison method employed by the students were reconstructed and subjected to analysis. The utilisation of the comparison method by the groups was correlated with individual results in Study 4, with

Spearman's  $\rho$  used to quantify the potential impact of the groups on students' progress. The Fisher's exact test was employed to ascertain the correlation between the strategies utilised to solve the comparison task and the individual students' improvement. Furthermore, the differences between German and French students were explored in order to identify any local specificities that could be taken into account when adapting scaffolds or developing further material to enhance comparison competency.

### 3.4 Comparative approach of this dissertation

“The thicker a comparison, the more intensely *comparative* it is.”

(Candea, 2018, p. 349)

It is important to provide an explanation and reflection on the comparative dimension of this dissertation, as it employs the comparative approach in a number of ways. Moreover, four articles from this dissertation engaged in an international comparison. In Studies 1 and 2, textbooks from Germany (North Rhine-Westphalia and Berlin-Brandenburg), England and France were compared. In Studies 4 and 5, two French classes and two German classes were compared.

A number of smaller comparison processes were undertaken throughout this dissertation<sup>3</sup>; however, only the international comparison is subjected to more detailed analysis in this section. Consequently, only the more comprehensive comparisons conducted in Studies 1, 2, 4 and 5 are subjected to in-depth analysis.

Although international assessment may be of interest in terms of policy or decision-making, this is not the focus of this dissertation. The aim of this dissertation is not to identify “better” students or “better” textbooks. Through international comparison, it is possible to test the competency model for comparison and the assessment tool in different countries and contexts, thereby validating these tools internationally. The objective of this dissertation is to provide an assessment tool and a first assessment of comparison competency based on international validation. This will contribute to the development of science literacy assessment initiatives in

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<sup>3</sup> For instance, micro-categorisation decisions were made in the content analyses (Mayring, 2014, see Studies 1, 4 and 5), or to classify the comparison tasks into the levels and dimensions of the competency model (Study 2), or in the case of the classification of the geography students' work into the types of comparison texts' structure (Study 3). In such instances, comparisons were conducted by comparing cases to theoretical models with the objective of classifying textbook tasks (Studies 1 and 2), texts produced by students (Studies 3 and 4) or group discussions (Study 5).

general, as well as to the validation of instruments in geography, in response to calls for validated instruments in this field (Bourke & Lane, 2017; Bourke & Mills, 2022; Kidman & Chang, 2022; Lane & Bourke, 2019).

Another objective of this dissertation is to explore similarities and differences between school systems with different textbook, school and subject cultures with regards to comparison (Hericks & Körber, 2007; Pepin & Haggarty, 2001). By examining how comparison is integrated in these specific contexts, it is possible to provide a thicker and decentered analysis of the results. Although France, Germany and England are all Western European countries and are therefore “commensurable”, the education systems of these countries are still a matter for national political decision-making, which makes them different (in Germany, education is the responsibility of the individual states, or *Länder*). As demonstrated in the theoretical section, comparison can be employed in many different ways, with varying scientific and educational objectives. The analysis of comparison tasks in textbooks can provide a specific analysis of how national or local school geographies integrate these scientific goals and/or reflect local variations of geography science. It is also interesting to observe how German and French students compare, as this penetration of scientific (geographic) culture and diverse comparison forms in school cultures may differ.

Finally, it can be interesting to see which difficulties remain common for students in both Germany and France while performing comparisons. From one perspective, the development of validated teaching tools or scaffolds can be a valuable resource, offering a common tool that can be implemented in different countries. However, it can also be adapted locally, taking into account potential differences between countries.

The objective of this dissertation is to provide “thick” comparisons that illustrate commonalities and each country’s distinctive characteristics. Additionally, it aims to validate and test tools and scaffolds that can be used internationally and/or adapted to local contexts. The objective is to navigate between nomothetic and idiographic analyses, while providing general validated tools and nuanced and informed local analyses.

In order to conduct research in other contexts, it is necessary to possess proficiency in the languages of those countries and to have an understanding of the local contexts. This is essential in order to ensure the “thickness” of comparisons. This was the case for the author of this dissertation and for the supervisors. This particular position implied to decenter the own perspective (Pepin & Haggarty, 2001). At the beginning of the project, the researcher’s own perspective (a French teacher in history and geography for secondary schools) was significantly influenced by the French school system and French subject or textbook culture (Hericks &

Körber, 2007). This was, in part, offset by the researcher's own new integration into the German textbook culture and the insights and guidance provided by the German supervisors of this dissertation, Prof. Dr. Budke and Prof. Dr. Schäbitz. This allowed also to be able to use scientific literature from the different countries to elucidate and substantiate the work.

After precisising the methodological approach in this chapter, the subsequent chapter presents the various studies.

## **4. The five studies of the cumulative dissertation**

### **4.1 Study 1: The objectives and uses of comparisons in geography textbooks: results of an international comparative analysis.**

**Citation:** Simon, M., Budke, A., & Schäbitz, F. (2020). The objectives and uses of comparisons in geography textbooks: Results of an international comparative analysis.

*Heliyon*, 6(8), 1–13. <https://doi.org/10.1016/j.heliyon.2020.e04420>



## Research article

## The objectives and uses of comparisons in geography textbooks: results of an international comparative analysis

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## ARTICLE INFO

## Keywords:

Education  
 Geography education research  
 Comparison  
 Comparative method  
 International textbook research

## ABSTRACT

Comparison is a cognitive process and a method of acquiring geographical knowledge widely promoted within school systems in Germany, France and England. Comparison is an everyday practice, but it is also one of the methods systematically used by geographers and serves various scientific purposes. However, little is known about the functions, extent and objectives of comparison tasks in geography education. This study presents an analysis of 20 textbooks from three countries: Germany, England and France. In this international comparative study we analysed all cognitive tasks involving comparison using qualitative content analysis and descriptive quantitative methods. We developed a reliable classification system for categorising the objectives of comparison tasks. In our results we demonstrated that a large proportion of comparison tasks in textbooks are simple, lower-order tasks. Also, many complex tasks in the three countries involve inductive processes, although we identified some national differences resulting from differing textbook structures. Our system for classifying the objectives of comparison tasks will help develop meaningful tasks, aiming to enhance students' autonomous and critical thinking, and improve their proficiency in the competencies and methods required in geography education.

## 1. Introduction

Comparison is not only an essential cognitive process, but also facilitates the acquisition and deepening of geographical knowledge. School systems in Germany, France and England widely support the use of comparison in geography education. The three countries included in this study use comparison in three different ways. In France, school curricula at all levels practically systematically include comparisons between cases at various scales (see for example [Ministère de l'Éducation Nationale, 2019](#), p.14; or [Eduscol, 2016](#), p.2). In Germany, "to compare" is one of the main command verbs used; it is an action that students must carry out at all levels of secondary education in geography classes ([DGfG, 2017](#), p.32). In England, contrasting and differential study of diverse phenomena, cases and countries is an integral part of the geography curriculum ([Department for Education and Skills and Qualifications and Curriculum Authority, 2004](#), p.102). However, none of these three national curricula specify or state the purpose of teaching and learning comparison as a method. Furthermore, there has been little research on this topic in geography education, and existing studies often date back some years ([Eichberg, 1972](#); [Stroppe, 1981](#); [Köck and Stonjek, 2005](#)). Hence, comparison is a "black box": a practice that is too obvious to

question. Yet, taken as a complex process that must be deeply thought out and justified with cogent argument ([Wilcke and Budke, 2019](#)), comparison can serve a range of different cognitive objectives. Teachers and textbook authors must take into account these objectives when designing tasks.

Since the curricula studied provide no precise information about comparison, and given that there has been relatively little research into its purposes in geography education, our research examined textbooks and investigated a variety of comparison tasks, in order to establish the types of tasks set. We analysed 20 textbooks from three countries: Germany (specifically North Rhine-Westphalia and Berlin-Brandenburg), England and France. In this comparative study, we looked at all cognitive tasks in these textbooks that included or implied a comparative process. We developed a reliable framework to categorise the objectives of these comparison tasks. We also undertook qualitative content analysis and quantitative analysis to characterise the different types of tasks in the textbooks studied. Our research questions were:

- How can we categorise the objectives of comparison tasks in geography education and establish a typology?

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<https://doi.org/10.1016/j.heliyon.2020.e04420>

Received 7 April 2020; Received in revised form 8 June 2020; Accepted 7 July 2020

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- To what extent do textbooks from the three countries include comparison tasks, and to what categories do these comparison tasks belong?

The first section of our paper presents the theoretical background and a classification system for comparison tasks. Then we present our methods, which included qualitative and quantitative analysis. The third section presents the results of our analysis of comparison tasks in textbooks, discusses our findings and state the potential of our classification system to help design comparison tasks for use in geography classes.

## 2. Theoretical background: how should comparison tasks be classified?

Comparison is the cognitive act of examining two or more units in conjunction, according to one or more variables, to assess similarities and/or differences (Namy and Gentner, 2002, p.6). In our everyday lives, we use comparison constantly to help us reason and categorise phenomena (Azarian, 2011, p. 115). Comparative analysis is also a scientific method. However, unlike everyday comparison, scientific comparison adopts systematic procedures and techniques in the definition and processing of comparison units and variables (Piovani and Krawczyk, 2017, p.822). The natural, and social sciences also use comparison as a method of acquiring knowledge, building theory and differentiating cases (Lijphart, 1971, p.682; Przeworski and Teune, 1970, p.5; Glaser and Strauss, 1967, p.105; Gervais-Lambony, 1994, p.20). In the social sciences, comparison has been seen as a scientific method for more than a century (Mill, 1882; Durkheim, 1967; Weber, 1921) and has helped to lay the theoretical foundations of the subject area. Comparison was also widely used by early geographers. For example, Humboldt (1807) compared vegetation zones in mountains, and Carl Ritter (1865) compared continents. Geography has a vibrant approach to comparison, especially in urban studies (Nijman, 2015; Robinson, 2006, 2011; Scott and Storper, 2014).

What are the objectives of comparison in the social sciences and geography? The first scientific objective of the comparative method is nomothetic, meaning it is used to determine theories and establish generalisations (Piovani and Krawczyk, 2017, p.823). Thus, it implies adopting a variable-oriented strategy (Ragin and Charles, 1987, pp.54–55) and identifying “universalising explanations” (Tilly, 1984, p.87), theoretical models and even ideal-types (Weber, 1921). The aim is to identify hypotheses and general laws via an inductive approach based on comparing examples (Lijphart, 1971, p.692). Diachronic comparisons can also be used to identify and define processes, via this nomothetic approach (Azarian, 2011, p.116). Some variations may then involve comparing models constructed with other examples in order to confirm or invalidate a pre-existing theory, or to complete or update it, using a deductive approach that involves testing a model with a potentially deviant new case (Lijphart, 1971, p.692; Tilly, 1984, p.116). In geography, for example, the analysis of American cities led to the emergence of urban theories and models that associated the city with modernity, industrialisation, and development (Burgess et al., 1925). These globalising theories have constructed ideal-types such as New York or Chicago, against which other cities have then been compared. This systematic comparison of urban examples with globalising theories is also found in the global city model (Sassen, 1999; Brenner and Keil, 2006).

The second objective of comparison is idiographic (Piovani and Krawczyk, 2017, p.3). This involves a more singular approach to cases and examples (Pickvance, 2001, p.12; Ragin and Charles, 1987, p.54–55), with the goal of demonstrating the uniqueness of observed facts (Gervais-Lambony, 2000, p.10). The nomothetic comparison approach has been criticised for its universal theoretical aims that may reduce the complexity of individual cases, or lose relevance when applied to too many cases (Sartori, 1970). In geography, nomothetic approaches have also been highly criticised for setting up an “imperial methodology” strongly marked by ethnocentrism and neo-colonialism (McFarlane and

Robinson, 2012; Robinson, 2006; Roy, 2009). One of the consequences of these approaches is the tendency to identify “other” cities as incomplete in regard to globalised, exemplary models (Peck, 2015, p.161), and the relevance of models or ideal-types in research strongly influenced by Western research structures and theories has been questioned. In response, many authors have called for a theoretical and methodological reconstruction of urban studies, and the establishment of postcolonial and critical research, in order to analyse all cities as “ordinary” (Robinson, 2006, p.109). In a larger sense, these debates raise the question which comparison units to use in geography if we want to avoid perpetuating stereotypical examples and promote decolonising, critical approaches, while also making scientific statements that apply beyond an individual case. Given this, an “intense dialectic between induction and deduction” is always required (Nijman, 2015, p.185).

Little attention has been given to comparison tasks in the research literature on geography education. Contributions to this topic are scarce (Eichberg, 1972; Stroppe, 1981; Köck and Stonjek, 2005). Comparison is often described as having only nomothetic objectives (Köck and Stonjek, 2005, p.258), via an inductive approach (Laske, 2013, p.285). Only Wilcke and Budke (2019) have proposed a six-step model for comparison tasks, in which all steps are carefully thought out and each choice justified with arguments (see Figure 1):

Firstly, the model postulates a preliminary problem that should guide the comparison work. Units of analysis must then be selected (Step 2), followed by variables (Step 3). These choices should be carefully considered and justified with arguments to avoid any risk of ethnocentrism in the definition of the variables and units considered (Piovani and Krawczyk, 2017, p.5). The next step is to contrast the similarities and differences of selected units along identified variables (Step 4). Yet comparing is more than that, since Step 5 involves explaining observed variations and relationships (Pickvance, 2001, p.11). In Step 6, the initial question is answered. This model contributes to defining comparison in geography classes.

The curricula of the three countries studied focus in particular on three different approaches to comparison. Firstly, in France, authors of instructions for teachers and official documentation accompanying curricula, relate comparison to inductive and nomothetic processes (Eduscol, 2016, p.4; Le Mercier, 2010, p.66). Indeed, French and English curricula have both involved in-depth analysis of case studies since the 2000s (Ministère de l'Éducation Nationale, 2000; Department for Education and Skills and Qualifications and Curriculum Authority, 2004, p.102) and comparison tasks are systematically implemented to compare cases in different locations and of various scales. With this approach, comparison helps to form concepts and rules using an example. Furthermore, teachers are asked to choose “representative” case studies for general geographical processes and concepts (Le Mercier, 2010, p.63). Secondly, in England, geography education has also been influenced by “enquiry-based learning” approaches (Roberts, 2003; Leat, 1998; Ferretti, 2013, p.106). Enquiry-based learning consists of the transposition of a scientific method into the classroom, and is used in higher education (Sonntag et al., 2017). It is also used in the experimental sciences in France during practical work (Reverdy, 2013, p.6). This constructivist approach uses projects, case studies and examples to engage students in solving geographical problems with geographical methods. Thirdly, in Germany, the curricula relate comparison to deductive processes (Senatsverwaltung für Bildung, Jugend und Sport Berlin, 2006, p.14). With fewer case studies and a greater emphasis on models and theory in the curricula, comparison tasks aim to train students to use models or to validate theory. There is therefore, stark contrast between the broad adoption of comparison in curricula, textbooks and the scientific context, and the lack of reflection on its precise objectives in geography education research.

Therefore, classifying comparison tasks into their inductive, deductive or idiographic purposes seems necessary to develop meaningful tasks in a competency-oriented geography class. Here we propose a classification system for comparison tasks according to their educational



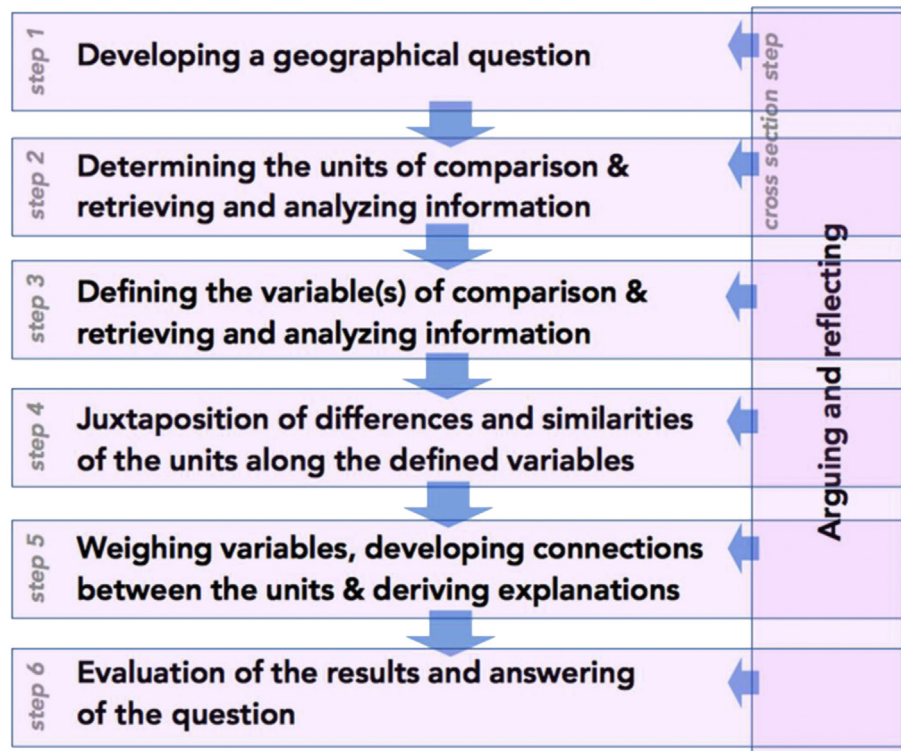


Figure 1. Method of comparison step by step. Wilcke and Budke (2019), p.8.

objectives in geography classes (see Table 1). This typology emerged while studying the objectives of comparison tasks in textbooks via a qualitative approach. Indeed, the analysis of the tasks' objectives showed that not only did they correspond to the various aforementioned scientific comparison objectives, but could also be divided into higher-order and lower-order tasks (Krathwohl, 2002; Jo and Bednarz, 2009; Krause et al., 2017).

The distinction between simple and complex tasks (see Table 1) corresponds, firstly, to the division stated by P. Gervais-Lambony (2000) and A. Lijphart (1971). They define simple comparison as everyday comparison, or as the juxtaposition of similarities and differences, without reflection or scientific objective. On the contrary, according to these authors, complex comparison implies an analysis and serves idiographic or nomothetic purposes. Second, this differentiation also corresponds to a division between higher-order or lower-order tasks based on existing taxonomies of educational objectives (Krathwohl, 2002; Jo and Bednarz, 2009; Krause et al., 2017). In addition to differentiating between simple and complex comparison goals, we identified, through category building, another five subtypes related to the nature of the comparison goals. Type 1 involves a nomothetic or interpretive approach, which is based on comparison between examples or case studies, and whether the task aims to generalise and establish rules, define concepts or properties, construct a model or develop a definition using hypothesis and theorisation (Skocpol and Somers, 1980; Lijphart, 1971), or aims to better understand and differentiate case studies. In its simplest version, it is limited to juxtaposing examples without drawing any conclusions or making any generalities. Type 2 consists of the reverse approach, which is deductive; the comparison consists of applying a model to a case study in order to practice or repeat the model. The complex version of this type involves confirming, criticising or refining the model through comparison, particularly through "deviant" case studies (Lijphart, 1971, p.692; Weber, 1921, p.1). The objective in Type 3 is to build a typology or classification system based on the comparison of several examples. In its simple form it is simply a matter of ordering the units being compared, whilst in its more complex form this comparison

leads to defining types using precisely chosen variables in a reflective process (Scott and Storper., 2014, p.3). Type 4 involves a temporal dimension that includes comparing units over time to distinguish or conceptualise processes or consistencies (Bartolini, 1993, p.136). A simple form of this comparison is comparing the elements over time without questioning the factors or processes underlying the observed changes. Finally, a specific category, Type 5, consists of the comparison and analysis of documents and sources by students. Here, the aim of comparison is to acquire skills in media literacy, or simply to identify different types of media. This category, which is broadly visible in our studied textbooks, distances itself from the others in that it considers the media used in the comparison in its own right. We used this five-type classification system to analyse tasks in our examination of textbooks.

### 3. Methodology

To understand the use of comparison we undertook an analysis of comparison tasks in 20 textbooks from France, England, and the German states of North Rhine-Westphalia and Berlin-Brandenburg.

Analysing textbooks from three countries requires an analysis of the context of geography education in each country to avoid the biases inherent in any comparative research. A common aspect of the use of comparison in the three countries is that, since the 1990's, they have all adopted an approach focused on skills and competencies, following a general trend across education systems in Europe and more broadly (Young et al., 2014; Klieme et al., 2007; Koch and Laske, 2014; Thémines, 2016). The focus shift from knowledge to competencies in the three countries is reflected in the curricula, which are now more output-oriented than input- or knowledge-oriented. But there are differences in the status of geography as a school subject and in the progressive specialisation of students, which occurs at different rates in different school systems. We could not include elementary schools since German curricula for these levels do not distinguish geography as an independent subject. Whilst in Germany, as in France, geography can be the subject of specialised study or more intensive teaching from 16-18

**Table 1.** Classification of comparison task objectives. Own elaboration.

	Simple comparison tasks	Complex comparison tasks
Type 1: Comparisons to build theory or to differentiate case studies	<p>Type 1.1</p> <p>Comparison of two or more units to establish if they are similar or different via a simple juxtaposition. e.g.: “Compare the flooding caused by a tsunami (see pp. 40–41), the flooding caused by flood events in Bangladesh (see pp. 46–49) and the flooding caused by flood events in Germany in terms of their causes, duration and consequences. Find similarities and differences.” (Hellmanns et al., 2016, p. 51)</p>	<p>Type 1.2.1</p> <p>Comparison of two or more units, including explanation of the findings, in order to establish a general rule, a concept, a model or a definition in an inductive way. =&gt; NOMOTHETIC APPROACH e.g.: “Compare the altitude levels of the mountains near the Equator (Andes) with those of the mountains far from the Equator (Alps). Make a list of similarities and differences. Formulate a rule that describes the changes in altitude levels from the equator to the pole.” (Bette et al., 2017, p. 153)</p> <p>Type 1.2.2</p> <p>Comparison of two or more units, including explanation of the findings, in order to better understand examples in an interpretive way. =&gt; IDIOGRAPHIC APPROACH e.g. “Thinking through your enquiry: You have been asked to write a report on behalf of the European Commission to explain why more industry and jobs are needed in the South of Italy. (...) You should write your report in five sections: 1. Introduction - How the South is different from the North.” (Hillary et al., 2001, p. 89)</p>
Type 2: Comparisons to apply or to test models	<p>Type 2.1</p> <p>Comparison of two or more units in order to apply a model or an ideal type, or to use a general rule, concept, model or definition. e.g.: “Compare the model [of demographic transition] with reality: describe similarities and differences.” (Bette et al., 2018, p. 51)</p>	<p>Type 2.2</p> <p>Comparison of two or more units to reflect on or criticise a model or an ideal type, or criticise a general rule, concept, model or definition. e.g.: “Model application. A. Work out the functional structure of Berlin on the basis of a large city map (e.g. in the Atlas). B) Assign it to a model of the functional outline. C) Then assess the significance of these models.” (Boeti et al., 2015, p. 331)</p>
Type 3: Comparisons to rank	<p>Type 3.1</p> <p>Ranking task for more than two examples to order them on a scale. e.g.: “Which EU countries are the most developed? The least developed?” (Plaza et al., 2016a, b, c, d, p. 369)</p>	<p>Type 3.2</p> <p>Ranking task with explanation and reflection on the variables, with a quantitative or hierarchical dimension, to define types or a typology. e.g.: “Name the months in which there is the smallest and largest selection of fruit and vegetables from Germany. Explain.” (Bette et al., 2016, p. 149)</p>
Type 4: Temporal comparisons	<p>Type 4.1</p> <p>Temporal comparison to characterise whether a change or a pattern are observed in time. e.g.: “Describe how agriculture changed between 1950 and 2013 using photos 1 and Table 2.” (Bette et al., 2016, p. 152)</p>	<p>Type 4.2</p> <p>Temporal comparison to characterise whether a change or a pattern is observed over time in order to provide an explanation and reflection on processes or consistencies. e.g.: “What inequalities between areas have become more severe as a result of metropolisation?” (Janin et al., 2019a, b, p. 37)</p>
Type 5: Comparisons to promote media literacy	<p>Type 5.1</p> <p>Comparison of different types of documents or sources, to learn how to read them. e.g.: “Compare the aerial photos of Münster: What exactly can you see, what less clearly?” (Bette et al., 2016, p. 25)</p>	<p>Type 5.2</p> <p>Comparison of different types of documents and sources in relation to the content or to the goals of the documents, to reflect on their use. e.g.: “What sort of maps would be most appropriate for displaying the following? - the population distribution within a country - the location of dairy farms in the UK - the ethnicity of different cities in the UK - the number of doctors per 1000 of the population of the UK - the main global migration of the past 30 years. Justify your choices” (Skinner et al., 2016, p. 629).</p>

years of age while remaining part of the common basic education, in England, geography teaching is only compulsory until the age of 14 and is then taught as an elective subject. Other differences are also apparent: firstly, while French and German secondary school curricula are very precise (about 30 pages depending on the level), English curricula are not very detailed (6–10 pages). Secondly, France has another particularity: geography is always taught in close relationship to history with the two disciplines considered to be sister disciplines (Tutiaux-Guillon and Nicole, 2008), both courses are taught by the same teacher and they are sometimes required to echo each other. As a consequence, for our study we only selected comparative tasks from the geography section of the French textbooks.

Our selection included textbooks from five different series and three other textbooks intended for students of secondary schools between 10 and 16 + years of age. The textbook series selected were, for Germany, *Terra, 1st ed.* (Bette et al., 2016, 2017, 2018; Boeti et al., 2015) and *Seydlitz Geografie* (Amstfeld et al., 2012; Hellmanns et al., 2016; Fleischfresser et al., 2016; Felsch et al., 2011); for France, we selected the textbook series, first, from Hachette *Histoire-géographie-EMC* (Plaza et al.,

2016a, b, c, d), and second, from Nathan *Géographie* (Janin et al., 2019a, b) supplemented with *Géographie Terminale* (Janin, 2016); for England, we chose *Think through geography, 6th ed.* (Hillary et al., 2000, 2001, 2002) and completed the selection with two textbooks for older students, *AQA GCSE (9-1) – Geography* (Widdowson et al., 2016) and *AQA A-Level - Geography, 4th ed.* (Skinner et al., 2016). The books came from publishers whose titles are commonly used in schools in the three countries. We also selected the textbooks based on their publishing dates. For France, we used the latest editions, and the German textbooks were also quite recent. For England, though, we deliberately chose three textbooks from an older curriculum implementing enquiry-based learning approaches. These constructivist approaches (Roberts, 2010, p.6; Ferretti, 2013, p.106) were used in English curricula from the 2000s and aimed to develop students’ scientific methods. The inclusion of textbooks applying enquiry-based approaches allowed us to investigate a possible English exception in the treatment of comparison within the tasks. These older textbooks were also supplemented with recent English textbooks corresponding to upper secondary school level.

**Table 2.** List of variables used in the textbook analysis.

Elements analysed	Variables	Levels
General aspects	Country	Germany, England, France
	Age of the students	10-11, 12-13, 14-15, 16+
	Location of the task in the chapter	Lesson, case study, methodology, revision
Comparison types and objectives (as presented in Section 1.1)	Presence of scalar comparison	Presence/absence of scalar dimension
	Comparison types	Type 1.1 to Type 5.2 (see Table 1)

Textbooks can not only be defined as pure educational media, but also as socio-cultural media representing a self-image of society that is, in many ways, filtered, pre-structured and controlled (Höhne, 2003, p.73–74). They are essential in the preparation and implementation of teaching sequences (Matthes and Schütze, 2011, p.9) and sometimes replace, or interpret, the curriculum. For Lee and Catling (2017, p.345), textbooks are the result of programmatic orientation and curricula, and differ depending on whether education systems promote closed or open teaching approaches. While in a closed, content-oriented approach, textbooks "emphasize mastery of key concepts and principles", in an open or student-oriented system, textbooks allow students to develop their knowledge more independently. The studied books presented differences in structure that reflect differences in curricula. In Germany the books were divided into thematic sections, the French textbooks were structured according to thematic-scale, with numerous case studies, and in England the structure was determined by the didactic "enquiry". Nonetheless, the studied books also had common features, all offering thematic double-pages, for example.

Tasks in textbooks are seen as vital for students to become competent in a skill (Matthes and Schütze, 2011, p.10, Menck, 2011, p.24). The analysis undertaken in this study considers the place of tasks in the "textbook system" (Nicolot, 2001, p.103). Indeed, tasks are not only an instruction or a sentence, but are part of a production context, and are part of the page, double-page, or chapter to which they relate. While in Germany and England the words "task" and "Aufgabe" have a similar meaning, in France the word "tâche" is used for the so-called "tâches complexes", which originate from language education and involve several stages and a final result produced by the student. Other types of tasks are called "questions" or "exercices" formulated using an "instruction"<sup>1</sup> or sometimes "evaluation". Tasks fulfil different functions and requirements depending on their purpose in the chapter, and thus also correspond to different competencies such as memorising, understanding, applying, analysing, creating and evaluating (Bloom, 1956; Krathwohl, 2002). In curricula that are increasingly competency-based and output-oriented, tasks are critical to the acquisition and exercise of these skills.

In the 20 textbooks studied, we identified 10,681 tasks, which were located in different chapter sections and fulfilled different functions. Across textbooks from the three countries, tasks were often visibly distinct from the textual sections aimed at transmitting knowledge (which we named "Main lesson") and were often associated with documents that the students had to study. In textbook sections involving case studies, tasks and documents were the main elements of the double-page spreads (we identified these sections as "Case studies"). Textbooks from all three countries often included sections designed to help students practice methodological skills, we therefore also included tasks with this purpose (which we refer to as "Methodology"). These sections were usually located at the end of chapters, as were "Revision" sections which were often limited to reproducing information or verifying knowledge acquisition. Tasks were either one isolated task, or included a set of subtasks. In the latter case, the sets of tasks often followed a pattern in which students had first to select or reproduce information, then to apply or explain it, and finally assess it.

This corresponds to the three hierarchical steps identified in taxonomies of educational objectives (Bloom, 1956; Krathwohl, 2002) and widely promoted in the German school system (e.g. DGfG, 2017, p. 31–32).

From this range of 10,681 tasks, all exercises involving a comparison task were selected and counted. Comparison tasks were defined as those that consisted of one or more subtasks that engaged students in the production or reception of a comparison, while contrasting the units of comparison according to one or more variables. After applying this definition to the 20 textbooks studied, 981 comparison tasks were selected for analysis (9.18% of the total number of tasks). The following sections present how we processed this data, firstly through a qualitative analysis, and secondly, through quantitative analysis.

We built and refined our classification of tasks into different types (see Table 1) using inductive-deductive category construction (Mayring, 2015 [1982], p.61) through a qualitative analysis. The classification was verified and refined using the Kappa coefficient calculation (Janko and Knecht, 2014): three trained judges were asked to classify all the tasks into the eleven categories formed by the types in their simple and complex form. We obtained the final Kappa coefficient of 0.66, which can be characterised as substantial (Landis and Koch, 1977, p. 165). This allowed us to assess the inter-rater reliability and the clarity of the classification, which was then used via a quantitative analysis to study the goals and the requirements of all comparison tasks from the textbooks for each of the three countries.

Along with identification variables (country, age of students), we classified the tasks in relation to specific variables concerning the tasks' level of complexity (see Table 1). The following variables were then used (see Table 2):

The first three variables allowed us to differentiate tasks according to country and targeted age group, and to identify the extent to which comparison tasks were integrated into the textbooks. The second group of variables enabled us to study the objectives of comparison tasks in textbooks. Here we studied whether tasks included comparison between units with different scalar dimensions, and identified the objectives of tasks using our typology (see Table 1). We differentiated between complex and simple tasks by taking into account what was explicitly asked of students. The following task is an example: "Compare the selected countries according to their ecological footprint" (Boeti et al., 2015, p. 257), which is from a German book for older students (category 16+ in the variable "Age of the students"), and is located in the main lesson part of the chapter on agriculture in different climatic zones (Location of the task in the chapter). The task is not formulated in a way that explicitly asks to interpret or explain the results, although it would be possible for students to do so. This task is therefore a simple ranking task (Type 3.1 in the comparison objectives, see Table 1). The comparison does not entail a change of focus in the given scale (Presence of scalar comparison).

After classifying the comparison tasks via the variables presented above, we carried out a descriptive statistical analysis of frequencies. These were cross-tabulated by country and age to undertake a comparison. As our sample exceeded a size of 100 and individual counts were not inferior to one, we also applied the Pearson Chi-Square Test to test independence between variables, using the commonly accepted level of confidence of 0.05. We complemented

<sup>1</sup> In French: "consigne".

our quantitative analysis with different examples from tasks, studied in the textbook context, to better understand and interpret our results. In the following section, we present the results obtained from these analyses.

4. Results and discussion

We identified that 9.18% of all tasks in the textbooks studied were comparison tasks, which is a significant number. This indicates that comparative tasks in the context of textbooks in all three countries have important educational functions and are tasks that students often have to perform. However, there were considerable differences between countries; while in Germany comparison tasks represented 9.72% of tasks, we found there were fewer comparison tasks in France (6.25%) and more in England (11.72%), in proportion to the overall percentage. There were also differences in the proportion of comparison tasks within overall tasks, depending on student age: in textbooks intended for 10-11 year-old students, 8.7% of tasks were comparison tasks, whereas the percentage was 7.3% in textbooks for 12-13 year-old students, 9.7% in textbooks for 14-15 year-old students, and 10.5% in textbooks for students aged 16 and over. This demonstrated that the number of comparison tasks increased slightly with the age of students.

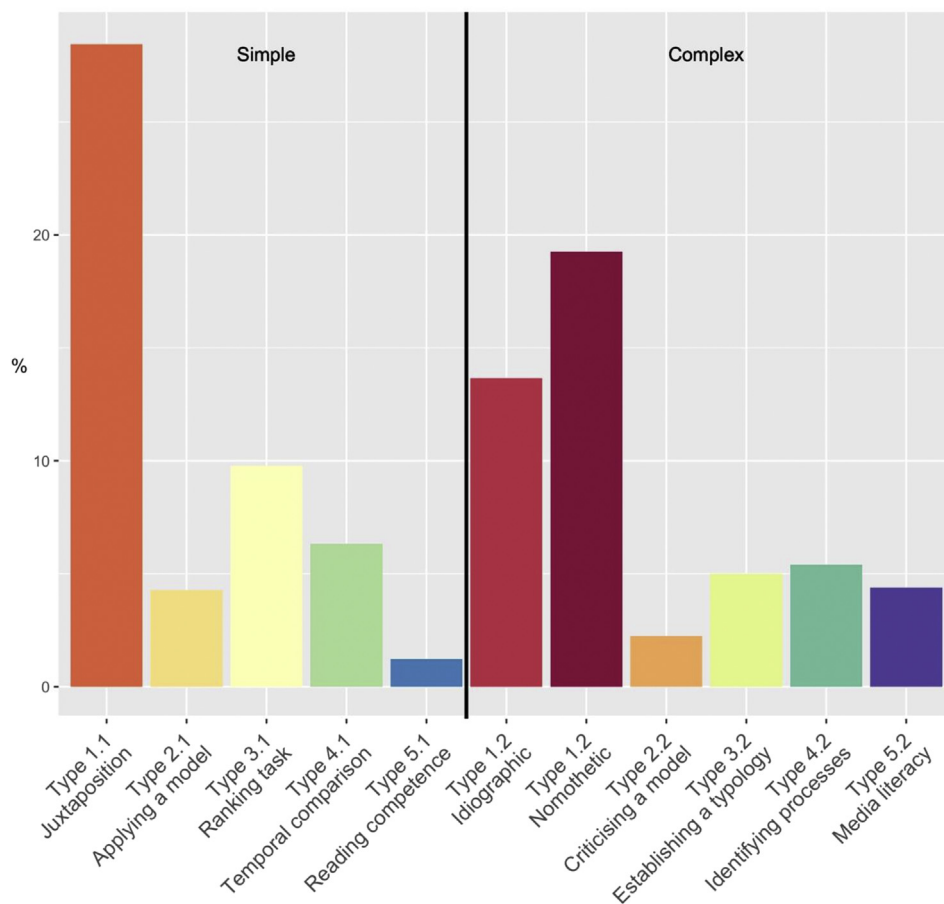
4.1. A general polarised distribution of comparison types

To better understand the functions and purposes of comparison tasks in the textbooks for our three chosen countries, all comparison tasks were classified into the different types of comparison previously identified (see Table 1).

Overall results showed that 50.15% of the comparison tasks analysed were simple tasks and 49.85% were complex tasks, meaning that more than half the tasks lacked higher-order goals, and consequently could not facilitate the acquisition of meaningful competencies or geographical skills. Type 1, in simple and complex versions, represented 61.36% of all tasks. Although this is in line with some of the main objectives of comparison in geography (Peck, 2015; Robinson, 2011), there is little use of the possible variations between comparison types, which could serve different objectives.

Simple juxtaposition of examples (Type 1.1: juxtaposition) could be particularly prevalent for a variety of possible reasons (see Figure 2). Firstly, these are tasks intended to make students describe places, regions or states, as shown in the following example: "Compare the structural data of Germany and Nunavut (table)" (Bette et al., 2017, p. 37). This task provides comparison variables (structural data) and units (Germany and Nunavut). Comparing is not an objective in itself as it also serves the purpose of learning about a geographical situation or reproducing information from the textbook. Closed or reproductive tasks are supposed to let students access to a preconstituted knowledge-base (Osborne, 2014, p.580) and indicate a subject-centred textbook design (Lee and Catling, 2017, p.345). The fact that they were prevalent in our study is in line with previous findings that also showed this predominance of closed tasks in geography textbooks (Graves and Murphy, 2000), including textbooks with enquiry-based approaches (Lee and Catling, 2017, p. 352).

Furthermore, these very frequently set tasks have similar characteristics to everyday comparisons, and can raise students' interest as they compare something familiar (in our last example, Germany) with something unfamiliar (in our last example, Nunavut). This has been debated, Young (2009) argues that everyday knowledge has limits and



N = 981

Figure 2. Distribution of comparison task goals. Authors' own graph.

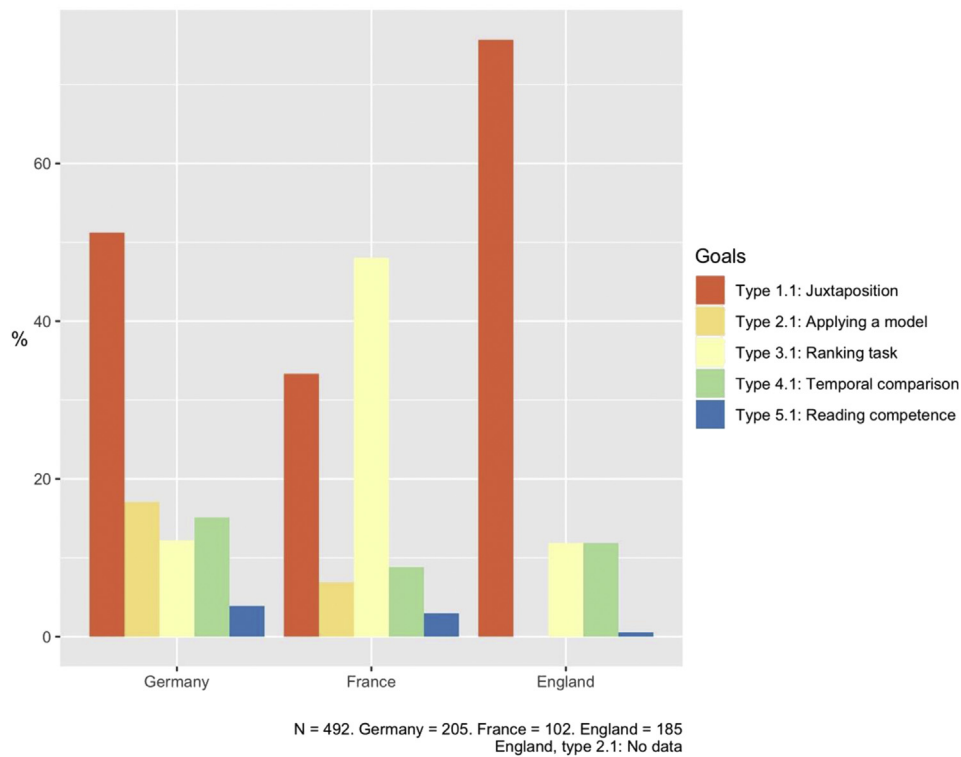


Figure 3. Distribution of simple goals to be achieved in comparison tasks. Authors' own graph.

that school knowledge allows more generalisations and access to “powerful knowledge”. However, using everyday knowledge can be valuable. Indeed, students are more interested and engaged in learning when local experiences and global or extralocal perspectives are connected (Klein, 1995, p. 365; Atherton quoted in Roberts, 2014, p. 193). Appealing to students’ experiences is also a way to link everyday

knowledge and school knowledge and to help students acquire skills and understand concepts or generalisations (Roberts, 2014, p. 192). This method is used in enquiry-based learning approaches (present in our sample via three English textbooks).

However, as seen previously (Part I), everyday comparison is not seen here as a method used to acquire specific competencies. Tasks were

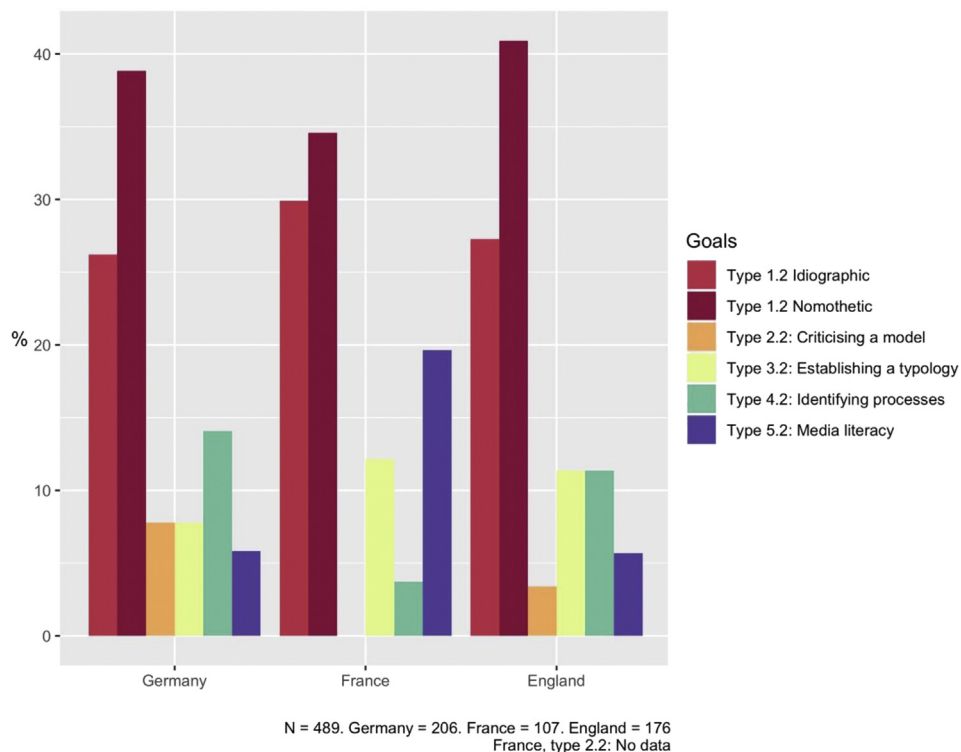


Figure 4. Distribution of complex goals to be achieved in comparison tasks. Authors' own graph.

classified as complex if they explicitly required explanation or reflection, or if students could choose variables or units in a reflective way. As this was not the case in our last example, we classified it into the simple category. Yet, depending on the students and their level of autonomy, or on the teacher, this type of task could also become complex. This is because “to compare” as a command verb is vague and does not systematically imply more than a simple juxtaposition: its interpretation can vary (e.g. *Ministerium für Schule und Weiterbildung des Landes Nordrhein-Westfalen, 2015, p.2*). Finally, it is also possible that textbook authors do not consider comparison as a competency to be developed, or do not include reflection on the comparison as a specific method. Therefore, a very large number of comparison tasks simply describe or approach comparison through a single element of the aforementioned process (*Wilcke and Budke, 2019*: juxtaposition (step 4)). Comparison, as discussed here, is a neutral zero-sum activity that does not participate in method acquisition and, most notably, reflection on the mechanism of comparison is absent or assumed to be self-evident.

Nomothetic and idiographic processes (see Part I) were present in many of the complex tasks studied. Consequently, there was a high concentration of comparison tasks based on these purposes (see *Figure 2*). This confirms the importance of comparison in geography education to gain knowledge through an inductive process as stressed in geography education research (*Köck and Stonjek, 2005; Laske, 2013*), in French curricula (*Eduscol, 2016, p.4; Le Mercier, 2010, p.66*), as it is also used in scientific comparison (*Lijphart, 1971*). An example of a nomothetic-oriented task is: “How do emerging countries differ from developed and less developed countries?” (*Janin et al., 2019a,b, p. 125*). In this example students are asked, using a map and a table presenting different countries, to compare examples, to build definitions and give the general characteristics of different development levels. This kind of passage from particular examples to general rules was found to be particularly prevalent in this study. Many tasks also adopted idiographic purposes, and were dedicated to better analysing and differentiating examples in an interpretive way, such as: “The earthquakes in Haiti and at Christchurch were of a similar magnitude but the death toll in each area was completely different. Why was this?” (*Skinner et al., 2016, p. 209*). Here students have to process a comparative statement between two natural catastrophes and their consequences in two different locations. To fulfil the task, students need to take different factors into account and better understand each of the places while identifying the differences between them.

Overall, the results showed a focus on inductive processes for comparison tasks, in a sample where the proportion of simple and lower-order tasks was higher than expected in a competency-oriented geography curriculum.

#### 4.2. Comparison task types and complexity, country by country: a few national differences

After stating overall results, in the following section we present a more precise analysis of the distribution, country by country, of simple and complex tasks (respectively 492 and 489 of the total of 981 tasks, see *Figures 3 and 4*).

Results showed the dominance of very easy exercises aimed at simple juxtaposition, particularly in German and English textbook tasks. German textbook tasks were less polarised than the other countries with a more even distribution of 1–2 goals of comparison. Tasks aiming to apply models, rank units or make comparisons in time were substantial in German textbook tasks. However this was particularly the case in textbooks from North Rhine-Westphalia and tasks from textbooks from Berlin-Brandenburg were more polarised. In France, two types of comparison were particularly common: ranking and juxtaposition tasks, with ranking being the more predominant of the two. The following task serves as an example: “Compare Chinese investments with those of other countries. How did they increase?” (*Janin et al., 2019, p. 105*). Here, students use a graph to solve the task, which is located at the beginning of

a case study about Chinese economic presence and spatial influence in Africa, and aims to show growing Chinese investments in Africa as compared to investments from other non-African countries. No explanation is asked for, instead ranking is used in this example as a starting point for further research questions and analyses. Finally, the focus on juxtaposition was particularly visible in English textbook tasks, while ranking and temporal comparison tasks were less evident but also common.

Studying the distribution of comparison types for complex purposes we observed the preponderance of the first types of comparison, in its nomothetic and idiographic dimensions, in all three countries (see *Figure 4*). Tasks with nomothetic aims were more common in all textbooks in general, although the gap between these and the idiographic aims was less marked in French textbooks. German and English textbooks had a relatively homogeneous distribution, although the German books did consistently use and critique models with a deductive approach. In this country, identifying processes also stood out, relatively speaking. For such tasks, the goal is to explain, define and characterise temporal changes such as demographic transition and economic development over time. For example, in the following task, students have to describe and explain the concept of deindustrialisation: “These images show the conversion of the “Zollverein” coal complex. It is a part of a change in the Ruhr area. Describe the two photos and compare them. Name this change and its causes” (*Amstfeld et al., 2012, p.93*). We also noted greater emphasis on temporal comparison to identify processes and reflection about typologies in English textbooks. French textbooks differed from the other two countries in that they did not use comparison to evaluate and critique theoretical models, and the use of comparison to develop competencies in media literacy was more developed than in the other countries. This is also linked to media literacy and the analysis of documents being part of the “Baccalauréat”, for which students are taught to reflect on and critique documents. Furthermore, the curriculum intended for the oldest students included a chapter reflecting on the use of maps, entitled “Maps to understand the world”. As an example, in the following task, students have to compare two maps; one of global demographic growth and another of global access to water. Students are asked to write an essay and analyse both documents. Different instructions guide them in this task, including questions such as: “Do the documents provide two similar, complementary or different views of the world? Justify your answer.” (*Janin, 2016, p. 55*). Here students have to reflect on the documents provided as sources and train their media literacy.

In general, our analysis demonstrates how comparison tasks aim towards slightly different goals in the three countries, even if common trends are observable in the overall distribution with a focus on juxtaposition for simple tasks, and on idiographic or nomothetic objectives for complex tasks.

#### 4.3. The integration of comparison tasks in textbooks: trends towards different purposes in the countries studied

How are comparison tasks integrated into different parts of the textbook chapters? We analysed this question by taking into account the location of the tasks within a chapter using qualitative content analysis.

Firstly, the distribution of comparison tasks in the different parts of the textbook chapters varied between the countries studied (see *Figure 5*). While German curricula were thematic and did not make particular use of case studies, in France and England case studies played a more important role and therefore entailed more comparison tasks. In French textbooks, there were also more comparison tasks in case studies than in the main lesson.

This specific structure of French textbook chapters, where case studies are used to arrive at general concepts and rules through an inductive process (*Eduscol, 2016, p.4; Le Mercier, 2010, p.66*), was reflected in the characteristics of the comparison tasks. The results showed a higher proportion of comparisons that contained an interplay between

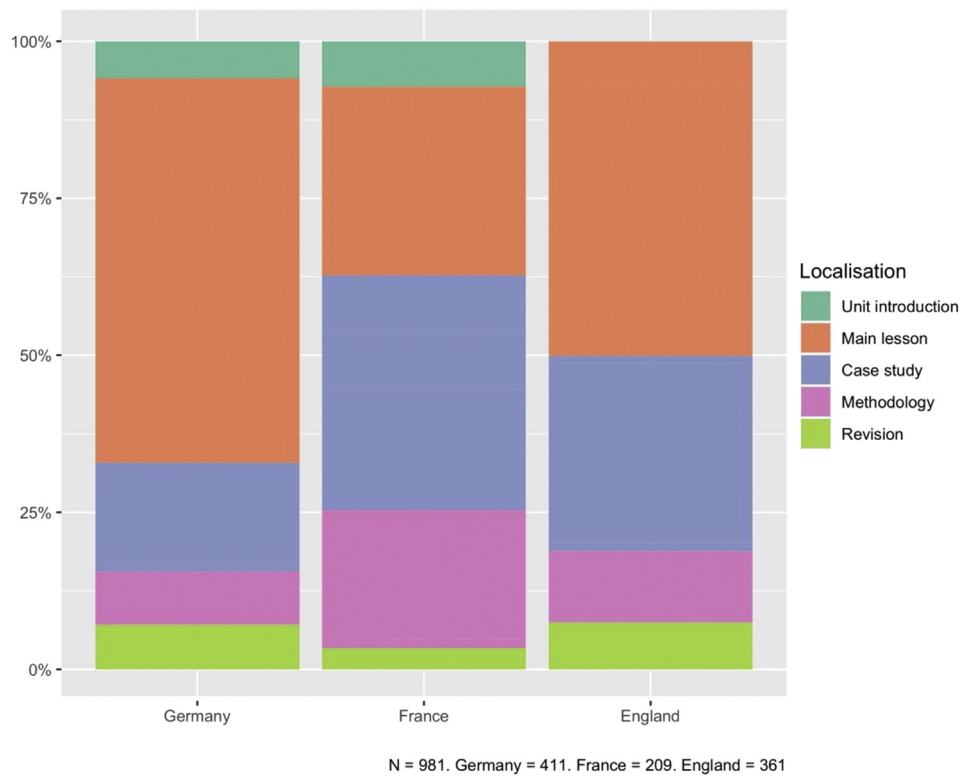


Figure 5. Location of the comparison tasks in the teaching unit. Authors' own graph.

case studies and other scalar levels: while 12.91% of the comparison exercises had a scalar dimension in France, only 4.13% and 4.15% did in Germany and England, respectively. This scalar dimension was used, for example, in specific case studies to compare processes (for example, demographic change or migration) in France with the same processes on larger scales, or globally.

German and French textbooks used comparison in introductions, while English books did not. Comparison tasks in introductions were mainly either inspired from everyday comparison approaches and aimed to relate the material to students' experiences or representations, or serve the purpose of stating working hypotheses or problems in a scientific way. This can be seen in the following task, which introduces the chapter "Urban areas and their inhabitants", and where two images of two cities must be compared: "Write down the similarities and differences between the two spaces presented. Develop a hypothesis to answer the following question: what are the visible functions of these landscapes?" (Plaza et al., 2016, p. 162–163). Through this task, students are asked to identify common elements in the definition of urban areas; in the images provided with the task, urban areas appear as economic centres, as spaces where there are transportation and mobilities, that are home to thousands of inhabitants, but they also seem different in terms of living conditions and basic equipment. The task serves to introduce these elements as

working hypotheses that are examined in the chapter's subsequent pages. Working with students' representations, everyday life and working with hypotheses are some of the different tools that can be used to initiate a stimulus and "create a need to know" (Roberts, 2003, p. 44) in enquiry-based learning approaches. These tools are important to raise students' interest and improve their learning (Ferretti, 2013, p. 104). In the three countries, textbooks appealed to students' experiences via case studies or tasks, or via fieldwork, particularly in England, as enquiry-based approaches are supposed to do (Roberts, 2014, p. 204; Klein, 1995, p. 365).

Lastly, there was a greater emphasis on comparison in methodology pages in France, although for the three countries comparison tasks were included in these sections. In the methodology pages comparison was used to practice other skills, such as media literacy or mapping competencies. In the revision pages the goal was to apply knowledge without working on specific skills related to comparison (as in the example from Janin, 2016, p.55, see part C) or to react to an existing comparison in order to evaluate it. Consequently, we found that comparison tasks were used differently in textbooks from each of the three countries studied, and served different goals depending on their location within the textbook.

To confirm whether or not there was a link between a task's location within a textbook and its purpose, we conducted a correlation test using

Table 3. Results from the Pearson's Chi-squared test of independence between a task's location and its type (See Part I). This contingency table presents the observed totals, [the expected cell totals], (the percentages per row).

Location in the chapter	Type 1	Type 2	Type 3	Type 4	Type 5	Total
Lesson	339 [328.31]	45 [34.90]	77 [79.08]	58 [62.72]	16 [29.99]	535 (54.54%)
Case study	174 [160.17]	7 [17.03]	46 [38.58]	32 [30.60]	2 [14.63]	261 (26.61%)
Methodology	53 [74.87]	6 [7.96]	16 [18.03]	18 [14.30]	29 [6.84]	122 (12.43%)
Revision	36 [38.66]	6 [4.11]	6 [9.31]	7 [7.39]	8 [3.53]	63 (6.42%)
Total	602	64	145	115	55	981 (100%)

$\chi^2 (12, N = 981) = 117.457, p < 2.2e-16$

**Table 4.** Results from the Pearson's Chi-squared test of independence between a task's location and its complexity. This contingency table presents the observed totals, [the expected cell totals], (the percentages per row).

Location in the chapter	Complex	Simple	Total
Lesson	246 [266.68]	289 [268.32]	535 (54.54%)
Case study	137 [130.10]	124 [130.90]	261 (26.61%)
Methodology	73 [60.81]	49 [61.19]	122 (12.43%)
Revision	33 [31.40]	30 [31.60]	63 (6.42%)
Total	489	492	981 (100%)

$\chi^2(3, N = 981) = 8.9587, p = .02985$

**Table 5.** Results from Pearson's Chi-Squared test of independence between task complexity and the age of students for which textbooks were designed. This contingency table presents the observed totals, [the expected cell totals], (the percentages per row).

Age of students	Complex	Simple	Total
10–11	63 [74.27]	86 [74.73]	149 (15.19%)
12–13	79 [94.71]	111 [95.29]	190 (19.37%)
14–15	160 [150.54]	142 [151.46]	302 (30.78%)
16 +	187 [169.48]	153 [170.52]	340 (34.66%)
Total (981)	489	492	981 (100%)

$\chi^2(3, N = 981) = 13.404, p = .003$

Pearson's Chi-Square independence test. The following cross-tabulation was obtained (see Table 3):

Our results showed that there was a significant relationship between the variables. Lessons and case studies tended to involve more inductive (Type 1) tasks, as expected, but involved fewer tasks enhancing media literacy (Type 5). Tasks located in methodology and revision sections tended to include more comparison enhancing media literacy (Type 5). Additionally, case studies tended to involve fewer deductive processes (Type 2), as expected. This result confirmed the aforementioned inductive function of case studies.

We also confirmed national teaching trends towards induction or deduction by locating the different comparison types in textbook sections, country by country: French textbooks tended to use inductive comparison tasks (Type 1) in case study sections, with 44.66% of Type 1 tasks in French textbooks located in case studies, whereas for German textbooks the same was only the case for 20.92% of the Type 1 tasks, and for English textbooks, the figure was 30%. On the other hand, in German textbooks, 80.39% of deductive comparison tasks (Type 2), which we already identified as more common than in the two other countries (see heading B. in this section), were concentrated in the main lesson, for England the figure was 50% and France only 7%. These results enabled us to refine our previous results and showed a slight difference in teaching orientations between countries, with German textbooks using predominantly deductive processes and French textbooks using predominantly inductive processes. In comparison, English textbooks tended to take the middle road, with no specific location for Type 1 or Type 2 processes. The specific focus on “enquiry-based learning” in the English textbooks included in our sample, therefore, did not clearly stand out.

#### 4.4. Task complexity variation in relation to location and students' age: discontinuous comparative competency building

How does task complexity vary? Can we assess variations in relation to the location of tasks? And in relation to the age of students? To answer these questions, we first tested the correlation between tasks' locations and their complexity (see Table 4):

Our results showed that there was a significant dependence between variables. Tasks located in the main lesson tended to be simpler than expected, whereas tasks located in case studies, the methodology and the revision sections of textbooks were more complex than expected. A

variety of different reasons may explain these results. Firstly, lesson sections entail fewer complex tasks than simple tasks because, for the textbook authors designing the section, lessons traditionally aim to provide knowledge that can be effectively taught through data comparison. The limited extent to which topics are presented in textbooks often does not allow for more complex comparisons, where different materials and comparison variables have to be considered. Consequently, complex tasks requiring more time and reflection are often located in other sections of textbooks. Yet, knowledge building and methodology competencies should not be systematically differentiated; meaningful tasks should aim to develop comparative competencies through reflection and argumentation on the comparative process at the same time as helping students acquire geographical knowledge and judgement and communication competencies.

Textbooks also integrated tasks to a different extent depending on the age of students. We analysed this via a Pearson's Chi-Square test and investigated the relationship between the complexity of comparison's objectives and the age of students (see Table 5):

Firstly, the proportion of comparison tasks increased with the age of the students for which the textbook was designed. Task complexity also tended to increase with the age of students and, as such, the two variables were not independent. These results were significant and revealed that textbook authors linked comparison with higher competencies, escalating with the students' age. Furthermore, we examined the distribution of complex tasks into comparison types in the different age levels per country. In all group levels Type 1 tasks (nomothetic or idiographic processes) were predominant. Type 4 tasks were frequent in lower age groups (temporal comparisons: 20.63% of tasks). In older groups, the distribution between the various types of tasks was less polarised, although the use of models (Type 2: 8.55% of tasks intended for 16+ year-old students, especially for Germany were they made up 12.94% of tasks) and document critiques (Type 5: 13.35% of tasks, and higher in France with 34% and England with 13.46% of tasks) stand out. As seen before (see Part I), comparison is a specific process that has to be developed and reflected upon, and increasing task difficulty seems appropriate in order to build this competency during secondary school according to a constructivist approach. Also, teaching students to carry out complex types of comparison is more likely to help students acquire and develop methodological and geographical competencies. It is also meaningful in the sense that reflective comparison can help develop critical thinking and judgement. However, younger students are also



capable of complex operations, so instead of being offered too many simple and meaningless comparisons they should be given the opportunity, via a differentiated assessment, to build comparative skills progressively. It should also be possible in lower age groups to study all different comparison types without only focusing on inductive or temporal processes, which are important but do not represent the variety of comparison possibilities.

## 5. Conclusion

While comparison is a process that is presented as self-evident in curricula, and is frequently used in geography classes, previous research has, thus far, not focused on the implementation of comparison tasks in textbooks. Yet, comparison in geography is very important in scientific analysis and has been fruitful in many ways, particularly with regards to methodological and epistemological debates in the discipline (Gervais-Lambony, 1994; Nijman, 2015; Brenner and Keil, 2006). Our study analysed the extent to which geography textbooks include comparative tasks that foster such geographical competency. To better categorise comparison tasks according to scientific objectives, we built a typology of comparison tasks in textbooks, the validity of which was subsequently tested. We used this classification for our international study, which compared geography textbooks from Germany, England and France, and allowed an initial exploratory approach to comparative tasks through qualitative and quantitative analysis.

Our empirical results showed that tasks tended to focus on only one type of comparison (Type 1) in the three countries studied. This can be explained by the fact that Type 1 objectives are fundamental objectives in geography (Peck, 2015; Robinson, 2011). They are then, as we might expect, practised as such in secondary education, however, too often using lower-order tasks involving juxtaposition (Type 1.1). It is also regrettable that we found no greater variability in objectives of comparison between the tasks. The ‘divide’ between school- and university-based geographies (Firth, 2011, p. 158; Roberts, 2014, p. 201–202; Clerc, 1993, p. 114), could be a reason why textbook authors tend to favour Type 1 and do not sufficiently consider other possible types used in scientific geography. However, comparison processes, such as the elaboration of typologies (Type 3), criticism of sources (Type 5), modelling or questioning of models (Type 2), and identifying the processes leading to the constitution of spaces or places (Type 4), are part of a geographer’s toolbox and should be taught in secondary education via relevant tasks.

It is regrettable that many comparison tasks we analysed did not promote the development of complex reasoning or argumentation. Tasks were often exclusively oriented towards the acquisition of simple knowledge, with a focus on closed teaching approaches observable in textbooks and curricula, as other research findings in geography education have already showed in the three countries (Budke, 2011; Lee and Catling, 2017; Colin et al., 2019). A large proportion of comparison tasks had only simple cognitive objectives and were not oriented towards competency acquisition. This result may suggest a lack of reflection on the part of textbook authors about the specific task and process that comparison constitutes (Wilcke and Budke, 2019). It also reflects the common misconception that the content of geography textbooks allows direct access to a “geographical reality”, and therefore students do not need to produce knowledge or acquire complex skills (Tutiaux-Guillon and Nicole, 2008, p. 119). Including meaningful comparison tasks in textbooks could reverse this situation: research shows that tasks allow students to learn specific ways of processing information, and not only to reflect on content (Doyle, 1983, p. 161). Moreover, in order to be able to critique or debate on geographical content, students must have access to the “epistemic tools provided by the discipline to construct knowledge” to acquire not only procedural knowledge, but also “knowledge on their own knowledge”, and therefore “powerful knowledge” (Young, 2014, p.20; Maude, 2016, p. 75).

Our typology appears to be a robust tool to analyse and develop tasks for several reasons. Firstly, the types obtained through category-building corresponded to different types of scientific comparison and types of tasks attested by scientific research (Lijphart, 1971; Krathwohl, 2002; Jo and Bednarz, 2009). Secondly, the reliability of our typology was checked through its use on our sample by different judges and the calculation of interrater agreement allowing a triangulation by researcher (Miles et al., 2014, p. 299). The validity of the typology was also confirmed by the fact that all comparison tasks could be classified within it. Lastly, the results of our quantitative analysis, carried out on a large and diverse sample, confirmed prior research results showing textbooks’ focus on lower-order and closed tasks (Budke, 2011; Lee and Catling, 2017; Colin et al., 2019), suggesting that the typology should be transferable to other contexts (Miles et al., 2014, p. 314).

Our international analysis showed common shortfalls across the different countries, even in the English textbooks using “enquiry-based” approaches. It also showed differences between the countries studied in curricular approaches as well as textbook design. Although our study did not analyse textbooks from different publishers within the countries, our results are in line with what research has described as different subject cultures (Hericks and Körber, 2007, p.31–32). Much could be learned from each specific textbook culture and applied in the different countries. For example, the use of case studies and fieldwork, particularly prevalent in France and England, is useful for implementing comparison tasks and methods, especially due to its inherent scalar dimension which is an important aspect of geographical thinking (Colin et al., 2019, p. 6). The systematic use of command verbs in task formulation in Germany is also useful for promoting the development of comparison competencies. The media literacy and documents critique tasks in French textbooks are also crucial to the development of reflection and argumentation on geographical content.

Our typology, specific to comparison tasks in geography education, constitutes an analytical framework that can be used to help textbook authors and teachers identify and develop meaningful tasks to grow students’ skills regarding comparison. It can particularly help in the analysis and design of tasks enhancing complex reasoning and argumentation. Varying the exercises and providing more space to research situations would appear to be more effective in a competency-oriented geography class, where comparison would be a tool used deliberately and in an informed manner. Further research could focus on developing a model to enhance this “comparative competency” as a goal in itself, indispensable to solid knowledge building and critical thinking.

## Declarations

### Author contribution statement

Marine Simon: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Alexandra Budke: Conceived and designed the experiments; Analyzed and interpreted the data; Wrote the paper.

Frank Schäbitz: Conceived and designed the experiments.

### Funding statement

This work was supported by Deutsche Forschungsgemeinschaft [57444011 - SFB 806].

### Competing interest statement

The authors declare no conflict of interest.

## Additional information

No additional information is available for this paper.

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## **4.2 Study 2: How geography textbook tasks promote comparison competency – an international analysis**

**Citation:** Simon, M., & Budke, A. (2020). How Geography Textbook Tasks Promote Comparison Competency—An International Analysis. *Sustainability*, 12 (20), Article 20.  
<https://doi.org/10.3390/su12208344>

Article

# How Geography Textbook Tasks Promote Comparison Competency—An International Analysis

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Received: 25 August 2020; Accepted: 7 October 2020; Published: 10 October 2020



**Abstract:** Comparison is an important competency for gaining and linking knowledge. It can be learned in geography classes to help students understand complex concepts and develop autonomous geographical thinking. However, we do not currently have any model to assess comparison as a competency in geography classes. In addition, little is known about how textbook tasks promote comparison competency. Therefore, in this study, a competency model for comparison in geography education was developed. It consists of four dimensions of comparison competency, which relate either to the mastering of comparison processes or to content-related elements of comparisons. Then, via a qualitative content analysis and descriptive statistics, the competency model was used to assess which dimensions of comparison competency were featured in 981 tasks from 20 German, English and French textbooks. Results showed that comparison tasks largely failed to promote autonomous and argumentative comparison process planning. However, numerous tasks performed better on the content-related aspects of comparison. Thus, the competency model presented in this study is a valuable tool to assess and enhance comparison competency in geography education and to promote students' autonomous geographical thinking.

**Keywords:** geography education research; comparison; international textbook research; comparative method; competency models; competency assessment

## 1. Introduction

Social sciences and geography use comparison as one of the most fruitful methods to gain knowledge. Comparison is not only a “central feature of scientific activity” [1] (p. 822), but, as a fundamental cognitive operation, it allows us to sort units and/or explain similarities or differences according to variables. It is central to children’s learning processes and, hence, can be used for educational purposes, for example in the form of a task in geography textbooks. Comparison is cited as a task in the geography curricula of various countries. In French and English curricula, comparisons are often based around case studies [2] (p. 14): for example, different countries’ vulnerabilities to risks are assessed with regard to the levels of development [3] (p. 102). In Germany, the educational standards insist on command verbs, including “to compare”, as specific actions in tasks that pupils must master [4] (p. 32).

Implementing comparisons in geography classes can contribute not only to the development of methodological skills, but also to the enhancement of content-related knowledge. Indeed, to compare in a meaningful way entails intense reflection on the different comparison units, comparison variables, and comparison objectives [5] (p. 685). Comparisons also allow us to make generalisations and contrast cases with controlled variables. Therefore, fostering comparison competency is crucial to enhance students’ autonomous, reflected, procedural and disciplinary knowledge. It is also a way to promote

knowledge that allows them to participate and build their opinion in significant debates [6] (p. 75) such as sustainability issues or spatial inequalities.

However, despite the prevalence of comparison in curricula and textbooks, research has not addressed the analysis of comparison as a subject-specific method or as a competency to be acquired by students. We do not currently have any competency model to assess comparison skills. Additionally, little is known about whether geography textbooks implement comparison tasks in a way that enhances comparison competency and its acquisition by students.

Therefore, in this study we propose a theoretical competency model for comparison in geography education. We used this model to analyse 20 textbooks from three countries: Germany (North Rhine-Westphalia and Berlin-Brandenburg), England and France. We led a qualitative content analysis as well as a quantitative analysis to characterise different types of tasks present in textbooks and evaluate them in relation to the competencies that these tasks should enhance. Our research questions were:

- How can we model comparison competency?
- To what extent do textbooks enable the development of comparison competencies: how many tasks address comparison and what competency levels are they supposed to enhance?
- Can we identify differences between countries with regard to the promotion of comparison competency in textbook tasks?

The first section of this article presents our theoretical background, and a competency model for developing comparison competencies. Then, we present our methods to analyse comparison tasks using both qualitative and quantitative analysis. In the third section, our empirical results reveal relatively insufficient competency-building in comparison tasks. Finally, we discuss our findings and state the potential of our competency model to help design comparison tasks for geography classes.

## 2. Theoretical Background: A Competency Model of Comparison in Geography Education

### 2.1. Comparison as a Competency

Comparison is the cognitive act of juxtaposing two or more units according to one or more variables to identify similarities and/or differences [7] (p. 6). For example, in the following task from a German textbook for 12 to 13-year-old students: “Compare three megacities of your choice at two different times” [8] (p. 93, own translation), students must reflect on the comparison units (here, megacities), which may be in different countries or continents. They also have to reflect on the variables they will use to compare units, such as spatial expanse or population, and the relevant dates. Comparison tasks are frequent in textbooks: comparing is fundamental for human reasoning and enables learning [9] (p. 103). For example, comparison produces changes in mental representations and knowledge by making it possible to classify elements and/or create categorisation systems [6] (p. 12). Comparison also allows general rules to be abstracted from concrete cases [10] (p. 31), [11] (p. 45) and then applied to new cases or situations [12] (p. 211). The use of comparison is thus a “powerful tool” [9] (p. 105) for learners and educators.

In geography science, comparison entails a content-related dimension since it allows reflection on disciplinary concepts or the production of knowledge about cases. In inductive or nomothetic approaches, comparison facilitates the development of models and the formulation of general laws [5] (p. 691), [13] (p. 87). It can also help to test developed models, identify deviant case studies [5] (p. 692), [13] (p. 116), and characterise processes using a diachronic approach [14] (p. 116), such as in our example, where students can determine the pace of growth in different megacities or differentiate cities with different development statuses. Comparison is also used, in a more interpretive or idiographic approach, to highlight the singularity of the examples studied [15] (p. 20). Comparison thus contributes to knowledge in both the social and the natural sciences.

Comparison also entails a methodological or procedural dimension. Scientific comparison is different from the intuitive comparison common in everyday life in that it involves systematic, controlled

methods [1] (p. 822). These methods are also the subject of discussion and debate within the scientific community, such as the four-step model developed by Hilker [16] and Bereday [17], which includes description, interpretation, juxtaposition and comparison. While some authors promote the use of fairly similar units—“Most Similar Systems Design”—in order to be able to control the observed variables [5] (p. 687), others on the contrary, favour comparing very different units in order to better understand the similarities around a given variable, despite differences on other variables—“Most Different Systems Design” [18] (p. 390), [19] (p. 34), [15] (p. 20). Different approaches to comparison are also a subject of debate in geography. An example of this are the discussions on the harmonisation of the units and variables used to compare urban systems across the world and test the validity of Zipf’s rank-size rule for city distribution [20] across different continents [21]. Therefore, comparison is not only pertinent for expanding our knowledge through its results, but comparison, as a process, carried out in a conscious and reflective way, also contributes to cognition itself [22] (p. 178).

Being a fundamental act of human reasoning and a scientific method, comparison is not absent from geography curricula. In Germany, France and England, students are frequently required to perform comparison tasks. Firstly, in Germany, where textbook and classroom tasks must correspond to different requirements and levels [4] (p. 32) [23,24], “to compare” is one of the main tasks students are required to perform in order to be able to transfer and/or analyse data. Secondly, in France, comparison is systematically used in geography classes to compare case studies with other scalar levels and derive explanations or general rules to be learned, via an inductive approach [25] (p. 4), [26] (p. 66). Finally, in England, understanding “the interrelations between geographical phenomena at different scales and in different contexts” is presented as equivalent to thinking “like a geographer” and is a requirement for passing the GCSE exams at the end of secondary school [27] (p. 3). Thus, comparison, in geography curricula and geography science alike, is considered both as a method and a way to gain knowledge and is hence present in textbooks.

However, it can be a very difficult task to perform and may be too demanding for some students without training or guidance. Given this, Wilcke and Budke [28] developed a six-step model to describe comparison as an argumentative and reflective process in geography education (see Figure 1).

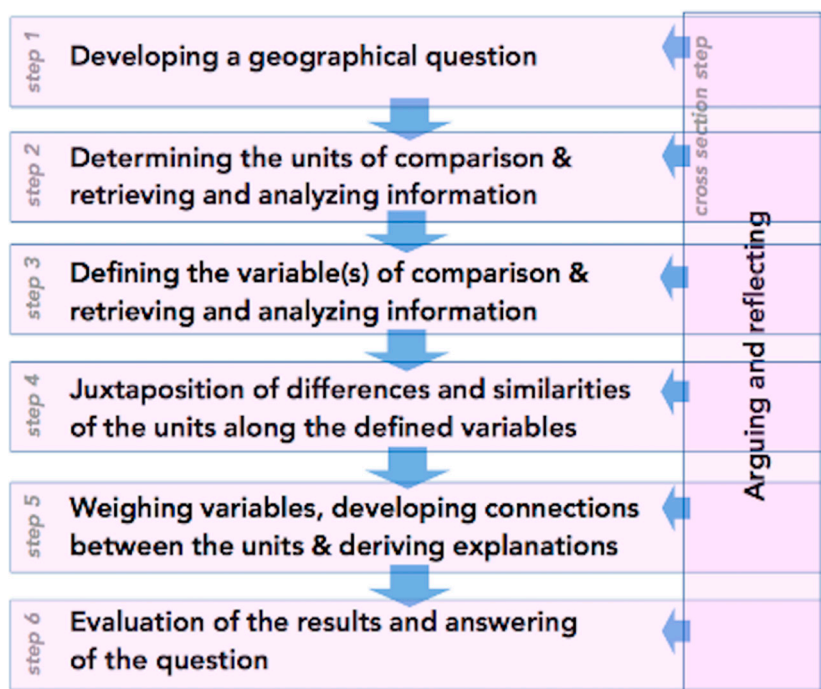


Figure 1. Method of the comparison step by step. [28] (p. 8).

To perform the task presented above in an informed manner, students would consequently have to weigh the variables and decide which problem or question they want to solve with the comparison. This task can be very demanding for students as it requires intense reflection on the choices made at each step of the comparison process. Although comparing is fundamental for human reasoning, it is neither a ready-to-use scientific tool, nor an easy method in geography education: our example shows that comparison has to be learned and practiced.

Given the above, we can characterise comparison as a competency. In the social sciences, competency is defined as a capacity or a disposition [29] (p. 73). A competency can be learned [30] (p. 8) and differs from the notion of performance or achievement, although competency is necessary to both [29] (p. 73). Education sciences have also defined educational competencies as “context-specific cognitive dispositions that are acquired by learning and needed to successfully cope with certain situations or tasks in specific domains” [30] (p. 9). Using comparison in geography education is not easy: it means being able to implement a systematic and reflective method, oriented towards geographical knowledge acquisition. It is a professional competency for geographers and can be learned in geography education; comparison is thus an educational competency for geography students, as is the case in other fields such as language and literature education [22] (p. 143).

The concept of competency has gained interest in the context of productivity- or performance-oriented policies [29] (p. 70), [30] (p. 3). In Germany, France and England, although skills and competencies are a new focus in curricula, which have been more output-oriented than knowledge- or input-oriented since the 1990s [31–33], there are no specific instructions in these curricula on how to approach comparison in geography classes as a competency. Furthermore, little has been written in geography education on comparison as a competency. Moreover, as a subject-specific method that can help students not only form generalisations and use and reflect on concepts, but also gain knowledge about their own knowledge, [6] (p. 74), comparison is one of the necessary tools for the acquisition of powerful knowledge in schools [6,34]. In addition, fostering comparison as a competency in geography education can help develop the students’ geographical skills, their maturity and autonomy towards geography as a science. Therefore, in the following section, we propose a competency model for comparison in geography education.

## 2.2. A Competency Model for Comparison in Geography Education

Here we propose a competency model for comparison. While there are various different proposals for competency models in geography education, none are specific to comparison. Competency models in geography education are one of the tools that can be used to foster and assess competencies, since they help to measure competency acquisition [32] (p. 11).

Existing models for comparison in other fields are not sufficient for assessing comparison in geography education. For example, Wellnitz and Mayer [35] (p. 328) studied comparison in biology education. However, their definition of comparison appears limited. Firstly, in their approach, comparison units are not subject to reflection, leaving variables as the only elements to be selected and justified in order to classify the different units. Secondly, the sole objective of comparison in their model is to classify or differentiate biological systems. Yet, as we have seen previously, in geography comparing has objectives that go beyond simple classification and ranking, for example nomothetic approaches.

Comparison can also serve different goals in geography education [36]. Here we propose four general objectives for comparison in geography education: to juxtapose examples in order to build models or rules or to better understand each case study inductively; to apply or test models in a deductive approach; to rank examples and establish typologies; and to acknowledge or identify processes diachronically, [36] (p. 4). As these objectives are not accounted for in the Wellnitz and Mayer model [35] (p. 328), another competency model, better adapted to geography education must be found.

Finally, it seems fundamental not to only consider the links between comparison and geographical knowledge. Developing comparison competency means developing content-related knowledge, but also procedural knowledge and knowledge about one’s own knowledge via the “epistemic tools”



used in the discipline [6] (p. 75). Therefore, in the following, we propose a competency model for comparison in geography education (see Table 1).

**Table 1.** Competency model for comparison in geography education (own elaboration).

Competency Levels	1st Dimension: Planning and Implementation of Comparison Processes	2nd Dimension: Reflection and Argumentative Justification of Comparison Processes	3rd Dimension: Interrelation of Geographical Information	4th Dimension: Achievement of Comparison Objectives
Level 4	Students can carry out comparisons within a self-selected question by independently selecting comparison units, comparison variables and material.	Students can justify their answer to the question argumentatively. They can argumentatively justify the choice of question, comparison units, comparison variables and material, and reflect on the limits of the comparison process.	Students can compare two or more comparison units using two or more variables and arrive at a meaningful answer to the question by weighting the variables and reflecting on underlying contexts or concepts.	Students can build rules/models (nomothetic process), better understand examples (idiographic process), or build a typology through comparison.
Level 3	Students can carry out comparisons within a given question. They independently select two or three elements of the comparison among the units, variables and material used to compare.	Students can justify their answer to the question argumentatively. They can argumentatively justify the choice of two elements of the comparison: either units, variables or material, and reflect on the limits of the comparison process.	Students can compare two or more comparison units using two variables and arrive at a meaningful answer to the question by weighting the variables.	Students can test a model or define processes or consistencies through comparison.
Level 2	Students can carry out comparisons within a given question. They independently select one element of the comparison: either units, variables, or the material used to compare.	Students can justify their answer to the question argumentatively. They can argumentatively justify the choice of one element of the comparison: either units, variables or material, and reflect on the limits of the comparison process.	Students can compare two or more comparison units using two variables and arrive at a meaningful answer to the question.	Students can apply a model or identify changes through comparison.
Level 1	Students can carry out comparisons within a given question with given units, given variables and given material.	Students can justify their answer to the question of the comparison argumentatively.	Students can compare two or more comparison units using one variable and arrive at a meaningful answer to the question.	Students can juxtapose or rank units to compare.

This competency model is divided into four levels (see Table 1) and postulates increasing competency between levels 1 and 4, level 1 being incomplete competency and level 4 being full achieved competency. In this model we assume that a level includes and goes beyond the competency achieved in a lower level. We also assume two different kinds of competency increases are possible: competency increases through the addition of new elements in a continuous progression, but also through leaps such as cognitive and conceptual change, via a global conceptual reorganisation of knowledge [37] (p. 187). We relate increasing competency with increasing complexity following Kauertz et al. [38] (p. 142–143), meaning, complexity is based on quantitative criteria, i.e., the number of elements involved, but also on qualitative criteria, such as the ability to include and consider interrelations or concepts.

In addition, our competency model is divided into four independent dimensions (see Table 1) which posit comparison as an educational and scientific tool in geography. The first two dimensions relate to competencies involving processes associated with comparison and argumentation. The first dimension (planning and implementation of comparison processes) refers to comparison as a process marked by different steps, as identified by Wilcke and Budke [28] (p. 8, see Figure 1). At level 4, students are autonomously able to compare, whereas, in the lower levels (1 to 3), teachers or the teaching material provide them with guidance through one or more steps of the comparison process. Students gaining in competency should gradually be able to select the constituent elements of the comparison autonomously. These elements include the units, variables and overall question, but also the material required to study and carry out the comparison.

The second dimension (reflection and argumentative justification of comparative processes) relates to the argumentation and reflection competencies required for the comparison process [28] (p. 8). Here argumentation is used to justify and explain the results [39] (p. 219), [40] (p. 11). Argumentation serves to justify the choices made in the comparison process and to reflect on the process itself, but moreover, it is an essential tool for developing other geographical competencies [40] (pp. 15–17) and contributes to students' scientific literacy [6] (p. 75), [41] via the comparison process.

The last two dimensions relate to geographical content-related elements of comparison. The third dimension (interrelation of geographical information) explores the specificities of knowledge and content related to comparison processes, such as reflection on variables and concepts, and the capacity to generalise and consider comparison contexts. The fourth dimension (achievement of comparison goals) concerns the content-related goals of comparison [36]. The first level englobes only juxtaposition and ranking, as in the following task: "Compare layered and shield volcanoes according to the following aspects: type of eruption, lava properties, shape and extent" [42] (p. 161, own translation). Here students have everything provided: material, units and variables. The goal of the comparison is only to juxtapose types of volcanoes, but not to reflect on the typology or to even establish types. In contrast, the second level is less simple, with the application of models and temporal comparisons. The third level involves reflecting on the models and being able to criticise them, as well as the ability to reflect on processes. Finally, the fourth level is similar to common scientific geographical practice: it involves using nomothetic and idiographic approaches within the comparison, as well as establishing typologies.

We applied this competency model for comparison in geography education to analyse tasks in textbooks and tried to establish the extent to which they are suitable for teaching comparative competency.

### 3. Methodology

To study which competencies comparison tasks effectively promote, we propose in this article an analysis of 20 textbooks from France, England, and Germany. We chose to analyse these three countries to try and identify possible national differences between their textbooks' approaches. An international analysis also enabled us to reflect on research biases due to the researchers' proximity to a known or to their own culture and to point out "possible directions that could be followed" [43] (p. 158).

Some similarities and differences in school systems and curricula should be mentioned: in the three countries, geography is a compulsory subject in secondary school: for students up to 14 years of age in England, and for students up to 18 years of age in Germany and France. As Germany does not teach geography as an independent subject at primary school, we did not include primary education. Therefore, we analysed textbooks intended for students of secondary schools (“Gymnasium” in Germany, “collège” and “lycée” in France, from 10 to 16+ years of age). School systems in the three countries also offer geography as a speciality subject to be chosen for national examinations. In France, geography and history are always taught by the same teacher and are considered as a “couple” [44] (pp. 89–90). We only analysed the geography sections of French textbooks, which included history and geography in the same book for the youngest students.

Textbooks are useful to study in order to analyse the extent to which comparison competencies are applied and taught, and which comparison competencies are enhanced (see Table 1). Indeed, textbooks, as educational media, are crucial to the preparation of teaching sequences and to actual teaching practices [45] (p. 9). They also reflect curricular orientations [46] (p. 345). As stated before (see Part I), comparison appears in the curricula from the three countries either as a task students are to perform [4] (p. 32) or as a way to infer generalisations from case studies via induction, or to demonstrate interrelations [25] (p. 4), [27] (p. 3). Analysing how textbooks actually enhance comparison competencies through tasks provides an interesting indication of how they may contribute to curricula in practice. Moreover, textbooks are an interesting source since researchers differentiate between the “real” curriculum, which is experienced by students [47] (p. 133), and the intended curriculum [48] (p. 5), reflected in textbooks [49] (p. 132), which are also part of the “potentially implemented” curriculum [48] (p. 5).

The textbooks were selected with the following criteria. First, since we wanted to get a broad impression of the different textbooks in the respective countries, we chose textbooks from different federal states if it was necessary. In Germany, where educational systems depend on the federal states, we selected the two states of North-Rhine Westphalia and Berlin-Brandenburg which are very different concerning the curricula in geography. In France and England, curricula are national: consequently, the textbooks were not from different regions. A second important criterion was the variety of publishers, whose titles had to be commonly used in schools. In Germany, the main publishers in geography education are Klett and Westermann, the companies that published the two series we chose. For France and England, we also chose famous educational publishers: Hachette and Nathan for France, Pearson and Hodder Education for England. Finally, we also selected textbooks corresponding to different theoretical approaches when it was possible: therefore, for England, some of the selected books were older and included “enquiry-based learning” approaches in their structure. Enquiry-based learning approaches were implemented in England in the curricula from the 2000s and were supposed to help students develop scientific and research strategies in the classroom through a constructivist approach [50] (p. 6), [51] (p. 106). Analysing textbooks using these approaches could help us identify a possible English exception when it comes to comparison, which may be treated explicitly as a scientific method to be acquired in the classroom. As a consequence of these choices, our final textbook selection included textbooks from five series: for Germany, we chose *Terra*, 1st ed. [42,52–54] and *Seydlitz Geografie* [8,55–57]; for France, textbooks were the series from *Histoire-géographie-EMC* [58–61] and *Géographie* [62,63] completed with the textbook *Géographie Term L-ES-S* [64]. For England, we chose the *Think through Geography* series [65–67] and supplemented them with two other books: *AQA GCSE (9-1)-Geography* [68] and *AQA A-Level-Geography, 4th ed.* [69].

Tasks are paratextual elements that engage students in a specific action [70] (p. 1325). Tasks, as questions, investigations, activities, are a central exercise in the learning process and a major tool to help students gain competency [45] (p. 10), [71] (p. 24). Tasks can be divided into different categories depending on their objectives: they can aim to help students to memorise, understand, apply, analyse, create or evaluate [23,24]. They also “influence learners by directing their attention to particular aspects of content and by specifying ways of processing information” [72] (p. 161).

The tasks from our sample were clearly identifiable, being separated from the main text of the lesson by means of a letter or a number, and sometimes consisting of one or more subtasks. They were located in diverse parts of textbooks, some of them being explicitly intended to train specific skills at the end of chapters in the revision or methodology sections. Many tasks were also associated with material to be studied by students through the task's formulation, which was sometimes framed as a question or using a command verb or imperative ("Operatoren", "verbes de consigne"). Sets of tasks often followed a pattern in which students had first to select or reproduce information, then to apply or explain it, and finally to assess it. This corresponds to the three hierarchical steps identified in taxonomies of educational objectives [23,24] and widely promoted in the German school system [4] (pp. 31–32).

We defined comparison tasks as follows: a comparison task, consisting of one or more subtasks, engages students in the production or reception of a comparison while juxtaposing comparison units according to one or more variables. The selection of tasks in textbooks from the three countries needed to take into account linguistic specificities: although in Germany and England the words "task" and "Aufgabe" are equivalent, in France tasks are called "questions" or "exercices". The term "tâche complexe" is rare and mostly used in language education. After carefully adapting to these linguistic differences, we selected and counted all comparison tasks from a total of 10,681 different tasks. Our sample consisted of 981 tasks (9.18% of the overall tasks).

Along with identifying comparison tasks and noting one independent variable (country), the variables were chosen so that it would be possible to classify the tasks in the different dimensions (see Table 1), thus using a deductively formulated category system [73] (p. 12). We examined in each task's formulation if students were asked to select units, variables, material or overall question (see variables used to analyse the 1st dimension of comparison competency, Table 2). Then, we focused on argumentation: if the task involved argumentation, we carefully observed to what purpose argumentation was required: to justify comparison processes or the results (variables used to analyse the 2nd dimension of comparison competency, see Table 2). We also counted the number of variables used in the tasks, noted when students were asked to weigh them and/or to reflect on the overarching concepts (variables used to analyse the 3rd dimension of comparison competency, see Table 2). Finally, all tasks were classified according to the various objectives they were intended to achieve (variables used to analyse the 4th dimension of comparison competency, see Table 2). To ensure the reliability of the classification, tasks were successively classified according to the different variables by two raters, and we also used inter-coder agreement to assess the reproducibility of our classification for the 4th dimension, obtaining a final Kappa coefficient of 0.66, which can be considered as substantial [74] (p. 165).

The classification was made taking into account the formulation of the task but also the presence and type of material provided to students on the textbook pages. As an anchor example [73] (p. 95), we will now explain our classification of the following task, using the different variables: "Compare the selected countries according to their ecological footprint" [54] (p. 257, own translation). This single sub-task came from a German textbook. It was not related to any specific problem to solve. Material was provided to the pupils (a graph), as well as one comparison variable (ecological footprint) and comparison units (41 countries). The task was formulated using the verb "to compare" and was a highly closed, lower-order task (see Table 1) that left little autonomy to pupils and only required them to reproduce information. While classifying the tasks, we formulated the encoding rule [73] (p. 95) that we only took into account what was explicitly asked from students. This task did not explicitly ask pupils to argue or reflect on the comparison process, therefore, in our competency model, it only achieved level 1 in each of the four dimensions since neither explanation nor argumentation were expected.

**Table 2.** List of variables used in the textbook analysis. Own elaboration.

Analysed Elements	Variables	Levels
Variables used to analyse the 1st dimension of comparison competency	Autonomy in the definition of a question or a problem to solve	Yes/No
	Autonomy in the selection of comparison units	Yes/No
	Autonomy in the selection of material to analyse	Yes/No
	Autonomy in the selection of comparison variables	Yes/No
Variables used to analyse the 2nd dimension of comparison competency	Argumentation explicitly required in the task formulation to explain the results	Yes/No
	Argumentation to justify the choice of material required in the task formulation	Yes/No
	Argumentation on the comparison variables required in the task formulation	Yes/No
	Argumentation on the comparison units required in the task formulation	Yes/No
	Argumentation on the question/problem required in the task formulation	Yes/No
Variables used to analyse the 3rd dimension of comparison competency	Number of comparison variables to use to compare	1, 2, 3 ... 10 +
	Weighting of variables	Yes/No
	Reflexion on concepts/contexts	Yes/No
Variables used to analyse the 4th dimension of comparison competency	Objectives of comparison	Levels 1, 2, 3 or 4 (see Table 1)
Independent variable	Country	Germany, England, France

The different dimensions (see Table 1) were then separately analysed in order to determine where the textbook tasks fall within the competency levels. We carried out a descriptive statistical analysis of frequencies which were cross-tabulated by country for comparison. In addition to our quantitative analysis, we examined different examples from tasks, studied in the textbook context, in order to better understand and interpret our results. These examples were carefully selected, qualitatively, as the most representative within the quantitative category identified in the statistical analysis.

In the following section, we present the results obtained from these analyses.

#### 4. Results

Our sample of 981 comparison tasks represented 9.18% of all tasks, which was a significant proportion, with differences between countries (Germany: 9.72%, France: 6.25%, England: 11.72%). In the first two sections, we examine which competencies the tasks achieved in the first two dimensions (see Table 1), and then we analyse in the third section how they fitted into the content-related dimensions (dimensions 3 and 4, see Table 1).

#### 4.1. How Did the Tasks Enhance Competencies for Planning and Implementing the Comparison Processes in the Textbooks?

We first analysed dimension 1 (“planning and implementation of comparison processes”, see Table 1) related to the degree of autonomy and planning agency required from pupils in the analysed textbooks (see Table 3).

**Table 3.** Classification of textbook comparison tasks in the 1st dimension: “planning and implementation of comparison processes” (see Table 1). Own elaboration.

	Germany (N = 411)	France (N = 209)	England (N = 361)	All (N = 981)
Tasks achieving level 4 (where students select all elements of the comparison process: question, material, variables and units)	0%	0%	0%	0%
Tasks only achieving level 3 (where students can select two or three elements of the comparison process)	4.1%	2.9%	9.1%	5.7%
Tasks only achieving level 2 (where students can select one element of the comparison process)	18.5%	21.0%	22.4%	20.5%
Tasks achieving only level 1 (where students have no autonomy in the selection of comparison elements)	77.4%	76.1%	68.5%	73.8%
Total	100%	100%	100%	100%

Very few tasks enhanced student’s autonomy in the comparison process (see Table 3). No task encouraged students to formulate their own problem to solve, and very little autonomy was left to them in the selection of the other possible elements of comparison, such as the selection of material (only 5.6%), comparison variables (12.3%) or comparison units (15.1%). Only a few tasks achieved level 3, and no task in any of the analysed textbooks achieved level 4. Nearly three quarters of tasks only achieved level 1 in this dimension and were designed similarly to this example: “Compare migration to and from Europe (documents 1 and 4). What do you notice?” [62] (p. 179, own translation). In this example, the comparison units and variables used to describe the topic (here migrant motivations and development levels), are provided in the material. Such tasks are oriented towards knowledge acquisition or media literacy through document analysis: students are to provide expected answers, and tasks are only used to verify this knowledge acquisition. Reflecting on the specific process of comparison is not the main focus of the textbook authors, who rather seem to concentrate on geographical content.

Results also showed differences between the countries, as we will now explain in more detail (see Tables 3 and 4).

**Table 4.** Proportion of comparison tasks enhancing competencies for planning and implementing comparison processes in relation to the countries. Own elaboration.

	Germany (N = 411)	France (N = 209)	England (N = 361)	All (N = 981)
Autonomy in the definition of a question or a problem to solve	0%	0%	0%	0%
Autonomy in the selection of material to analyse	2.9%	1.9%	10.8%	5.6%
Autonomy in the selection of comparison variables	13.6%	7.6%	13.6%	12.3%
Autonomy in the selection of comparison units	10.7%	17.7%	18.6%	15.1%

Firstly, our figures (see Tables 3 and 4) revealed that in English textbooks students had more autonomy in the comparison process, which was somewhat less controlled by the task. Material and comparison units were less frequently provided to students than in the other two countries, which made the tasks less constraining than in Germany or France, and may constitute an English exception due to the “enquiry-based learning” approach. For example, the following task, taken from an English textbook for students of 12 years of age, provided room for autonomy in the selection of material, units and variables: “In groups, research different types of alternative energy—the advantages and disadvantages of each. As a class decide which you think will be the most important in the future. You might like to produce a poster, leaflet or Powerpoint presentation to show your findings”. [66] (p. 43). Students were encouraged to look for material themselves, to investigate and to be able to reflect on the documents they found in a real research situation. This is part of what Margaret Roberts has called “creating a need to know” [75], p. 44) as a strategy to stimulate and engage students in a research process. Appealing to the students’ experiences (here, also, to their opinion) is also a strategy to interest them in enquiry-based learning approaches [76] (p. 204), [77] (p. 365). Finally, asking them to “decide”, “as a class”, seems to appeal to them to make a democratic political decision and can contribute to their political education [78] (p. 11), [79] (pp. 803–804). This interesting task was associated with a chapter about energy distribution and energy as a resource and could raise students’ awareness about sustainability issues. However, it was located in the last part of the “enquiry process” of the teaching unit, in the “homework” part of the double-page and was not essential to the geographical skills- or knowledge-acquisition involved in the chapter. Some tasks in textbooks are indeed not designed to demand much time from students, so that the teacher can get to the point of the lesson quite rapidly, in response to perceived time constraints in geography education [80] (p. 6–7).

Secondly, in French textbooks, students were rarely able to select variables on their own, whereas in Germany, they were less autonomous in the selection of units (see Table 3). The results revealed that tasks were significantly closed in both countries. However, in France, case studies are used at the start of chapters to introduce important thematic definitions. The topics of the case study are subsequently examined at different (widening) scales, in order to identify differences or commonalities across places, or countries inductively. For example, in the textbook for the “classe de Quatrième” (13–14 years of age), the following task was found: “Show that the story of Koudous Seihon’s migration resembles many others” [60] (p. 275, own translation). Here the students had to visit a website and describe an example of a migrant journey across the Mediterranean Sea. The goal is not to reflect or highlight the diversity of possible ways to characterise migration, or to define its variations: the goal is to identify common and general features characterising international migrations through one example, rather than to differentiate variables or reflect on the meanings of the concepts. Comparison in French textbooks is, then, often used to generalize and introduce or reproduce already available knowledge [81] (p. 178), but not to gain autonomy in the research methods or processes. In Germany, there is even less autonomy left to students in the selection of units: in this country the objective is more to reflect on variables. Mastering the comparison process while weighting variables can be highly useful [28] (p. 8). However, it can also constitute a hinderance to understanding the diversity of cases and can lead to the use of more stereotypical and unnuanced examples [82] (p. 75), [83] (pp. 103–104), [46] (p. 346).

Our overall results for this first dimension generally revealed that there was very little room for autonomy left to students in comparison tasks across the three countries. Results also showed differences between countries, due to different curricular or theoretical approaches.

#### *4.2. How Did Textbook Tasks Enhance Competencies Related to Argumentation and Reflection?*

In a second step, we analysed whether or not tasks encouraged students to use argumentation to justify the results of comparison and, if relevant, how argumentation was used to justify the procedure in the comparison process (see Table 5), as required in the model developed by Wilcke and Budke [28] (see Figure 1).

**Table 5.** Classification of textbook comparison tasks in the 2nd dimension: “reflection and argumentative justification of comparative processes” (see Table 1). Own elaboration.

	Germany (N = 411)	France (N = 209)	England (N = 361)	All (N = 981)
Tasks achieving level 4 (where students can argumentatively justify their results, select all elements, and reflect on the limits of the comparison process)	0%	0%	0%	0%
Tasks only achieving level 3 (where students can argumentatively justify their results, select two elements, and reflect on the limits of the comparison process)	0.25%	0%	0%	0.1%
Tasks only achieving level 2 (where students can argumentatively justify their results, select one element, and reflect on the limits of the comparison process)	1.9%	0%	2.5%	1.7%
Tasks achieving only level 1 (where students can argumentatively justify their results)	20.4%	26.3%	26.9%	24.1%
Tasks not explicitly requiring argumentation	77.45%	73.7%	70.6%	74.1%

Results (see Table 5) revealed the small extent to which students are required to use argumentation in comparison tasks, with many tasks that did not fall into levels one to four of our model. Only 17 tasks achieved level 2, asking students to justify the selection of one comparison element. Only one task in our sample asked students to reflect on and justify more than two elements in the comparison process and therefore achieved level 3. No task achieved level 4.

These elements showed, firstly, how low the proportion of tasks explicitly asking students to argue is, and, in the small proportion of tasks requiring argumentation, how content-oriented they are designed to be. Argumentation, when it was explicitly called for, was mainly aimed at justifying elements relating to content or to the results of comparison. This is particularly the case in French textbooks, where argumentation is very much linked to reasoning [84] (p. 3). Colin et al. [84] (p. 7) have revealed the limited extent to which reasoning in school geography actually corresponds to geographical (spatial) reasoning. Indeed, many French tasks asked students to “show” or “prove” a predetermined result of the argumentation, as in the following task: “Why do we talk about American power but only about the ascension of Brazil? (doc 1 and 2)” [64] (p. 183, own translation). This task comes from a chapter comparing the United States of America and Brazil in terms of economic development and political power, introducing the concepts of “emerging” (Brazil) and “developed” countries as well as “global power” (USA). In the task, students must discuss the result of the comparison, but they are not asked to reflect on the process leading to it or reflect on the categories or concepts. Conversely, German textbooks tend to ask students to prove or show predetermined results less frequently, as a possible consequence of a refusal to impose knowledge or ideology on to students—as was once common practice in geography classes of the former German Democratic Republic [85].

When analysing the performance of tasks in this dimension, therefore, we found that argumentation was not thought of as a means to acquire methods or knowledge, but rather used to explain obtained results. The tasks in the textbooks studied were not considered by their authors as an opportunity to teach students how to plan and carry out a comparison as part of an autonomous research process, in which they would learn how to use argumentation to support their choices.

The results for the second dimension of comparison competency showed how tasks are mainly closed tasks failing to engage students into acquiring methodological skills and reflective geographical thinking.



#### 4.3. How Did the Tasks Enhance Content-Related Competencies for Recognising and Interrelating Geographical Information and Competencies to Help Achieve Comparison Goals?

Finally, we analysed the distribution of tasks in the two content-related dimensions: the third and fourth dimensions (interrelation of geographical information, and achievement of comparison goals).

Our analysis of the third dimension showed that 92.6% of tasks required the management of only one variable (88.1% in German books, 97.1% in French books, 95% in English books). Thus, an overwhelming majority of tasks only achieved level 1 in the third dimension (see Table 1). As a consequence, only 6.2% of tasks (10.2% from German books, 1.9% of French books, 4.1% of English books) achieved level 2, with the involvement of two variables. In only one task did students have to weigh variables, thus attaining level 3. Finally, very few tasks (1.1%) asked students to use comparison contexts or to reflect on concepts.

In the following task from a French textbook, students were supposed to compare different indicators and weigh their relevance to measure different aspects of development: “What are the components of the Social Progress Index? ( . . . ) Compare this document with the Planisphere: do developed countries necessarily rank highest in the Social Progress Index? What differences do you notice? Using your answers, show that the Social Progress Index is a way to add nuance to the measures of development and economic performance of states”. [62] (p. 159, own translation). This task used comparison as a tool to understand the interpretive value of different indicators used to compare states and balance the classical financial indicators with other dimensions of welfare and development such as social factors. Interestingly, it helped students to understand different aspects of the concept of development. Although students could only select units (and no other comparison element), which caused this task to only achieve level 2 in the first dimension, it achieved level 4 in the third dimension related to the content of comparison.

The fact that only very few tasks achieved a higher level in this dimension also reveals that textbook authors do not appear to place importance on the construction of geographical content and knowledge through interrelating and weighting variables and elements. Tasks in studied textbooks do not place students in a research situation, even in studied textbooks using enquiry-based learning approaches, which did not differ on this point from other approaches in our sample. It should also be noted that deeper reflection on comparison processes seems difficult given the limitations of the double-page spread [86] (p. 236), which is the common layout adopted in our textbooks across all three countries.

We also analysed in Table 6 content-related comparison competencies through the objectives of comparison tasks (fourth dimension, see Table 1).

**Table 6.** Classification of textbook comparison tasks in the content-related 4th dimension “achievement of comparison objectives” (see Table 1). Own elaboration.

	Germany (N = 391)	France (N = 185)	England (N = 350)	All (N = 926) <sup>1</sup>
Level 4: Building rules/models, better understanding examples or building a typology through comparison.	38.4%	44.3%	40%	40.2%
Level 3: Testing a model or defining processes or consistencies through comparison.	11.5%	2.2%	7.4%	8.1%
Level 2: Applying a model or identifying changes through comparison.	16.9%	8.6%	6.3%	11.2%
Level 1: Juxtaposing or ranking units through comparison.	33.2%	44.9%	46.3%	40.5%
Total	100%	100%	100%	100%

<sup>1</sup> The sample here was reduced to 926 tasks, since 55 tasks had the objective of exercising media literacy via the comparison of documents. Thus, these 55 tasks did not correspond to our identified 4 types relevant to geographical content-related objectives.

Our results in this fourth dimension (see Table 6) showed a polarised distribution of tasks between either easy and lower-order objectives (juxtaposing and ranking tasks only achieving level 1), and difficult and higher-order objectives (building rules/models or a typology and better understanding examples, achieving level 4). This confirmed the difference initially identified (see Part 1) between ways to define comparison: it is firstly an essential reasoning tool applied to human experience and is used as such in many tasks to make students aware of differences or commonalities. It can indeed be useful to pique students' interest via simple tasks [76] (p. 192), but some have criticised the use of everyday experience as a limiting approach: to them, education should take students beyond their personal experience [34]. Secondly, comparison is also used, although rather infrequently, to replicate or reproduce scientific methods and processes, with the aim of implementing inductive, nomothetic or idiographic approaches. This significant result shows how comparison is envisaged by textbook authors as a tool to gain knowledge (as it is also characterised in curricula), and how it is in fact used via case studies or examples to help students form generalisations or build rules.

Once again, there were differences between countries: in German textbooks the distribution was less polarised than in English or French ones, with more variation in the functions of tasks. In Germany, models such as city models were also more explicitly used in textbooks. German textbooks also included more demanding tasks (level 4) than tasks achieving any other level, whereas French and English textbooks included more lower-order tasks (only achieving level 1).

The overall results in dimensions 3 and 4 of the competency model (see Table 1) showed that tasks performed better in the fourth dimension related to the content-related goals of the comparison. Nevertheless, the potential offered by the comparative method is not reached by the tasks, which do not propose reflection on contexts or the evaluation of variables (third dimension).

## 5. Discussion

In this study, our aim was to develop a competency model for comparison tasks in geography class. We used this model for the further analysis of comparison tasks in a corpus of textbooks from Germany, France and England, in order to test its relevance for such an analysis.

Our competency model proposes four dimensions of comparison competency. Dimensions of comparative competency include not only comparison methods, but also argumentation by justifying choices made during the comparison, allowing the development of scientific literacy [41]; reflection on the variables and the context of the comparison; and also the scientific objectives related to the content of the comparison. This comprehensive approach to comparative competency is in line with calls for the promotion of "powerful knowledge" in geography education, including methodological knowledge, geographical knowledge, knowledge that goes beyond the individual experience of students, and knowledge about one's own knowledge [34].

Analysis of the task distribution in the textbooks studied using our model demonstrated firstly, the low proportion of comparison tasks that could achieve a satisfactory level in the first three dimensions. The low level of autonomy left to students in the comparison process, as seen in the first dimension, highlighted the very closed and reproductive nature of the comparison tasks, which is in line with other research findings on the nature of tasks in geography textbooks in the three countries [87] (p. 261), [46,84]. These closed tasks can be of interest if the objective is to have the students learn science in the sense of an "existing, consensually-agreed and well-established old knowledge" [81] (p. 178). Additionally, comparison tasks that are strictly reproductive can sometimes be of interest to serve the purpose of raising students' interest [75] (p. 44). However, since few tasks allowed students to select the elements of the comparison, few tasks required them to justify the selection or reflect on the comparison process, as analysed in the second dimension, and rarely entailed argumentation, as previous research also found. This is regrettable, since alone reproductive tasks do not enable students to interrelate information, nor to solve complex operations, nor to reflect and argue on one's own knowledge. Finally, the results in the third dimension showed that textbook authors do not consider the possibility of using comparison to interrelate geographical information and reflect on

variables or on the context, which is also in line with the results obtained in the previous dimensions. The first three dimensions (planning and implementation of comparison processes; reflection and argumentative justification of comparison processes; interrelation of geographical information) are then highly interrelated and show concordant results. These results reveal the very limited extent to which textbook authors consider comparison as a competency and as a process that is important for students to manage autonomously and exercise, even though curricula emphasise its relevance and despite the fact that this autonomy would be necessary in geography education designed to facilitate the acquisition of “powerful knowledge” [34] (p. 75).

In the fourth dimension (achievement of comparison objectives) however, results showed a polarised distribution and a relatively higher ratio of achievement of level 4 among the tasks. These elements confirm findings about the objectives of comparison tasks [36] and the textbooks’ focus on lower-order and closed tasks [46,84]. Textbook authors oriented tasks more towards content-related objectives, than methodological or competency-building functions in regard to comparison, which is in line with previous findings [88], [46] (p. 352). It also implies that textbook authors have particularly high expectations regarding content-related competencies. It also highlights how textbook authors and official curricula do approach comparison as a “powerful tool”, [9] (p. 105) to gain knowledge or consider how it can be used to formulate geographical concepts or better understand cases, as it is in geography science [89,90]. However, this content-oriented perception of comparative tasks is incomplete and restrictive without proper reflection on the methods, interrelations and argumentations that should be used in comparison. It leads to the fact that students learn few approaches to critically question the results of comparisons they encounter in everyday life, e.g., on the Internet or in the newspaper.

The overall poor results correspond to previous findings which showed how textbooks often focus, in geography and science education, on the end product of science, seen as a truth, rather than on a view of science as a construct up for debate [44,70,91]. If tasks are “mediating tools for the culture of science and science learning in school” [70] (p. 1332), then comparison tasks should leave more autonomy in the determination of the comparison units, elements and their weighting as well as include argumentation to support and reflect on the comparison process. Indeed, argumentation contributes to the development of other geographical competencies and to understanding [40] (pp. 15–17), [92] (p. 5). It also allows students to build knowledge on the cognitive processes involved in geography and on their own competencies [6]. Reproductive tasks can sometimes be of use [81] (p. 178) and purposely included, but, this study also showed that there is room for manoeuvre in the designing of more demanding and comprehensive comparison tasks in geography textbooks and material.

Our international analysis mostly showed commonalities between the countries, although national differences were also visible. German textbooks tended to reflect more on variables and models in comparison to the textbooks from the other countries. English textbooks implementing enquiry-based learning approaches, left more autonomy in comparison processes, whereas, French textbooks seemed to leave very little agency to students in the different possible answers to comparison tasks. These differences highlight the potential of enquiry-based learning approaches, even though the implementation of these was in fact limited [76] (p. 103). They also confirm the existence of different textbook and subject cultures in geography education: French textbooks, oriented towards content knowledge and reasoning are influenced by *encyclopaedism*, whereas the analysed English books, leaving more agency to students, show the influence of individualism in the English school system [43] (p. 158) and German textbooks promote propaedeutic knowledge via the emphasis on content-related competencies [93].

Our results show that our model can be of use, firstly, to evaluate the possibilities offered by textbook tasks in different countries for the acquisition of comparison competency. Classifying the tasks proposed in textbooks in this model can be of interest in order to choose interesting tasks to use in the classroom or to adapt them to the desired level. It can also be used by textbook authors or teachers to design comparison tasks and either monitor students’ progression or assess and work on different levels within the class. It is thus possible to use the model in different teaching strategies, such as internal

differentiation or to control the learning curve. More broadly, implementing the competency model for comparison can promote learning and developing scientific methods in geography education. This can also contribute to developing students' content and procedural knowledge and critical thinking on geographical and societal issues such as sustainable development or spatial conflicts. Finally, further studies could test the implementation of this model and its predictive validity in real classroom situations. Research could also test the competency model in different educational systems and address the necessary local adaptations or improvements.

**Author Contributions:** Conceptualization, M.S. and A.B.; Data curation, M.S.; Formal analysis, M.S.; Funding acquisition, A.B.; Investigation, M.S.; Methodology, M.S. and A.B.; Project administration, A.B.; Supervision, A.B.; Visualization, M.S.; Writing—original draft, M.S.; Writing—review & editing, M.S. and A.B. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research was funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation)—Project Number 57444011—SFB 806.

**Acknowledgments:** The authors would like to thank Frank Schäbitz for his valuable feedback in different stages of the research and for the collaboration in the overarching project.

**Conflicts of Interest:** The authors declare no conflict of interest.

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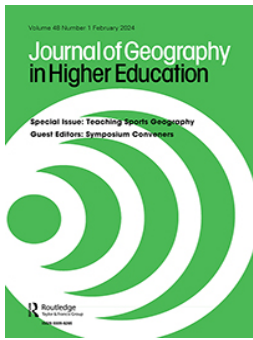


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### **4.3 Study 3: Students' comparison competencies in geography: results from an explorative assessment study**

**Citation:** Simon, M., & Budke, A. (2024b). Students' comparison competencies in geography: Results from an explorative assessment study. *Journal of Geography in Higher Education*, 48 (1), 94-114. <https://doi.org/10.1080/03098265.2023.2174960>





## Students' comparison competencies in geography: results from an explorative assessment study

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To cite this article: Marine Simon & Alexandra Budke (2024) Students' comparison competencies in geography: results from an explorative assessment study, Journal of Geography in Higher Education, 48:1, 94-114, DOI: [10.1080/03098265.2023.2174960](https://doi.org/10.1080/03098265.2023.2174960)

To link to this article: <https://doi.org/10.1080/03098265.2023.2174960>



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Published online: 05 Feb 2023.



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RESEARCH ARTICLE



## Students' comparison competencies in geography: results from an explorative assessment study

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### ABSTRACT

Comparison is an important geographic method and a common task in geography education. Mastering comparison is a complex competency and written comparisons are challenging tasks both for students and assessors. As yet, however, there is no set test for evaluating comparison competency nor tool for enhancing it. Moreover, little is known about university students' and prospective teachers' comparison performances and writing strategies for comparison texts. Therefore, in this study, we present an assessment tool aiming to evaluate comparison competency and assess comparison text structures. This tool can also be used as a possible scaffold to teach comparison competency. In order to evaluate the reliability and validity of the assessment tool, we tested it on a sample of 17 future geography teachers from a German university. Results showed that students possessed low levels of comparison competency, although they performed better in content-related aspects. Students utilized only a few of the available comparative text structures. Finally, results from the two parts of the assessment were positively correlated, linking comparison competency to the quality of the text structure. This shows that higher education geography programs should include content on comparison text structures when teaching comparison competency to help future teachers develop this skill.

### ARTICLE HISTORY

Received 15 March 2022  
Accepted 22 November 2022

### KEYWORDS

Comparison competency;  
geographical skills;  
competency assessment;  
scaffolding

## Introduction

Comparison is a fundamental cognitive activity (Goldstone et al., 2010, p. 103) that allows abstract rules to be extracted from concrete examples (Gentner & Markman, 1997, p. 45; Gick & Holyoak, 1983, p. 31) and helps classify and organize knowledge (Namy & Gentner, 2002, p. 12). Comparison is also a central scientific method (Piovani & Krawczyk, 2017, p. 822) that is widely used and discussed in geography (e.g. Robinson, 2006, 2011). In geography education, comparison is also common: comparison tasks represent a substantial proportion (9.18%) of geography textbook tasks in secondary education (Simon et al., 2020, p. 6). Therefore, it is an important competency for students to master (Simon & Budke, 2020, p. 2).

Although students at all levels often carry out comparisons in geography classes, there is no research to date on the comparison competencies of students and prospective

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teachers, nor do we know which strategies they use for comparison in geography classes. We do not yet dispose of a tool to assess comparison competency and writing strategies for texts presenting comparisons. This confirms the need for the development of assessment instruments for geographical literacy, as identified by Lane and Bourke (2019, p. 19). This is a critical issue, not only in the broad context of secondary geography education, but also in the context of higher education and teacher training in the field of geography. Indeed, prospective teachers must master comparison competency in order to be able to teach it. Failing this, they will not be able to identify the needs and strengths of their future students and help them develop this competency themselves. Providing information about students' comparison competencies to professionals in higher education can help them shape or rethink curricula in order to redress any gaps in students' professional development.

Therefore, in this study, we present an assessment tool which was tested with 17 bachelor students, prospective teachers from the Institute for Geography Education at the University of Cologne in Germany. The tool was developed as practical application of our competency model for comparison in geography (Simon & Budke, 2020) and used to assess students' comparison skills. The aim was to identify the students' strengths and weaknesses when making comparisons, in order to be able to address challenges in the teacher training program on this basis. The skills were tested through a task consisting of an open question instructing students to compare different migration accounts. Students had to answer in written form, for example via an essay.

Our research questions were:

- How can the comparison competencies of geography students be validly assessed on the basis of the comparison competency model (Simon & Budke, 2020)?
- How competent are geography students when asked to write an essay to solve a comparison task?
- How are the writing strategies they use related to their comparison competency?

This article begins with the theoretical background for the development of the test (2. Theoretical background). This is followed by a description of the methods we used in the development of our assessment tool and how it was tested in relation to prospective students' competency (3. Methods). The results section presents the test results and identifies the strategies used by students to solve the task (4. Results). Then, we discuss the implications of the test for the development of further educational concepts and educational tools to enhance comparison competency (5. Discussion).

## Theoretical background

### *Theoretical, empirical and educational debates about comparison and comparison competency*

Comparison is a common geographical research strategy and an important competency, which is transmitted in geography classes in secondary education (Simon & Budke, 2020), and which higher education geography students involved in their initial teacher

education should be able to teach and to assess. However, different theoretical, empirical and educational problems arise while considering this objective.

First, comparison is one of the established (Krehl & Weck, 2020, 1860) but also often discussed research methods in the humanities and social sciences. Traditionally, scientists use comparisons to be able to formulate generalities from particular cases (Durkheim, 1967); Lijphart, 1971, p. 682; Przeworski and Teune, 1970, p. 5; Weber, 1921). Geographers too compare urban or regional spaces realizing variable-oriented comparisons in a theory-oriented approach (Cox & Evenhuis, 2020, p. 425; Krehl & Weck, 2020, 1860). Some of these approaches have been strongly debated in the last twenty years. For example, scholars questioned the legitimacy of the generalization of Eurocentric concepts used to compare cities across different continents (eg. Robinson, 2006; Roy, 2009). Recent approaches call for using comparison as a tool for identifying common processes between examples whose specificity is irreducible (Robinson, 2022). To be able as future teachers to didactically reconstruct the comparison method, university geography students have to understand the implications and stakes of these recent theoretical debates.

Secondly, empirically, the comparison methodology itself is also subject to numerous debates. There are “not so much” comparative works (Kantor & Savitch, 2005, p. 135), no systematic implementation of comparison (Kantor & Savitch, 2005, p. 136), and what defines a “good” comparison study is not always clear (Krehl & Weck, 2020, 1860). For example, selecting comparison elements (comparison units and variables) has implications for the results and reflection is very much needed along the whole comparison process. Scholars from urban studies recently explored different comparative methodologies, trying to “reformat” comparison methodologies (eg. Robinson, 2022). Krehl and Weck (2020, pp. 1867–1871) also proposed five questions that they believe should systematically underpin case study research such as to identify underlying theories and concepts (1), to reflect on the ambition to generalize (2), on the selection of cases (3), on comparison objectives (4) and on the trade-offs realized during the process (5). But, the comparison methodology remains scarcely studied which can lead to difficulties while didactically reconstructing it with students.

Thirdly, these important theoretical and empirical debates from the fields of human geography and urban studies are not to be found in current research in geography education. Comparison studied as a task and as a competency in geography education is still a young research field. Only did Wilcke and Budke (2019) propose a systematic comparison method as a tool to be used in secondary education. In their model, first, students have to identify a specific question to be resolved via the comparison. Second, they have to choose comparison units (i.e. objects to be compared) and variables to compare them (i.e. aspects or criteria through which objects are compared). Then, they juxtapose comparison units and identify similarities and differences in order to provide an answer to the initial problem. They analyse this result by weighting variables, deriving explanations and/or inferring general rules. While comparing, each step of the comparison process should ideally be justified and reflected (Wilcke & Budke, 2019, p. 7).

University students may not be newcomers to comparison processes since comparison is part of geography curricula in secondary education, either through case studies used to infer general rules on larger scales (e.g. in France: Ministère de l'Éducation Nationale, 2019, p. 3) or as a particular task aimed at applying acquired knowledge to new situations

(e.g. in Germany: Deutsche Gesellschaft für Geographie, 2017, p. 32). It is therefore an important school competency in secondary education (Simon & Budke, 2020). But, few tasks in English, German and French textbooks enhance the development of comparison competency, since they rarely allow students to autonomously select and justify the variables, units, material or questions relating to the comparison (Simon & Budke, 2020). Many comparison tasks concentrate on simple objectives, rarely requiring higher-order thinking (Simon et al., 2020). Therefore, although they might be familiar with comparison tasks, little is known of how secondary or university students are effectively competent when they compare. Moreover, there is no existing scaffolding tool to teach comparison competency while adapting to the level of students and to help them develop this skill.

### ***Development of a tool to assess and foster comparison competency in geography education***

To be able to develop and adapt university programs and initial teacher education related to the comparison method, evaluation of students' comparison competency at the beginning of their higher education programs is needed. However, there is no valid or reliable assessment for comparison competency. As pointed by Lane and Bourke (2019, p. 11), assessment in geography needs more validated instruments to evaluate students' competencies. Such an assessment instrument for comparison competency is not only needed for competency evaluation: it can also be used formatively as a scaffold to foster competency development while adapting to each student. Scaffolding (Wood et al., 1976, p. 90) involves the provision of tools by a teacher to enable a student to acquire new skills or knowledge in their "zone of proximal development" (Vygotsky, 1978, p. 37). These tools are a support allowing students to gradually move out of their current learning zones into other zones that are less comfortable but still close to them. Adapted to each student, scaffolding tools are only temporary and teachers progressively remove them once students become more competent (Van der Stuyf, 2002, p. 11). Therefore, this article takes the competency model for comparison proposed by Simon and Budke (2020, see Table 1) as the theoretical basis to develop an assessment instrument which can also be used as a scaffold.

In this model, comparison competency is composed of four dimensions: two related to the comparison process, and two related to comparison content and objectives. Each dimension is divided in competency levels, from the lowest (level 1) to the highest level (level 4). The higher the competency, the higher the level obtained. The first dimension (planning and implementation of comparison processes, see Table 1) allows us to ascertain if students are able to autonomously select the elements of the comparison (question, comparison units, variables, material). The second dimension (reflection and argumentative justification of comparative processes, see Table 1) assesses students' ability to justify their chosen comparison processes, from explaining comparison results to justifying the choice of comparison elements. The third dimension (interrelation of geographical information, see Table 1), relates to students' ability to manage complex comparison content, for example, the ability to deal with more than two comparison units, or to weight variables. Finally, the fourth dimension (achievement of comparison objectives, see Table 1) relates to students' progressive ability to understand higher-order

**Table 1.** Competency model for comparison in geography education (Simon & Budke, 2020, p. 5).

Competency levels	1 <sup>st</sup> dimension: planning and implementation of comparison processes	2 <sup>nd</sup> dimension: reflection and argumentative justification of comparison processes	3 <sup>rd</sup> dimension: interrelation of geographical information	4th dimension: achievement of comparison objectives
Level 4	Students can carry out comparisons within a self-selected question by independently selecting comparison units, comparison variables and material.	Students can justify their answer to the question argumentatively. They can argumentatively justify the choice of question, comparison units, comparison variables and material, and reflect on the limits of the comparison process.	Students can compare two or more comparison units using two or more variables and arrive at a meaningful answer to the question by weighting the variables and reflecting on underlying contexts or concepts.	Students can build rules/models (nomothetic process), better understand examples (idiographic process), or build a typology through comparison.
Level 3	Students can carry out comparisons within a given question. They independently select two or three elements of the comparison among the units, variables and material used to compare.	Students can justify their answer to the question argumentatively. They can argumentatively justify the choice of two elements of the comparison: either units, variables or material, and reflect on the limits of the comparison process.	Students can compare two or more comparison units using two variables and arrive at a meaningful answer to the question by weighting the variables.	Students can test a model or define processes or consistencies through comparison.
Level 2	Students can carry out comparisons within a given question. They independently select one element of the comparison: either units, variables, or the material used to compare.	Students can justify their answer to the question argumentatively. They can argumentatively justify the choice of one element of the comparison: either units, variables or material, and reflect on the limits of the comparison process.	Students can compare two or more comparison units using two variables and arrive at a meaningful answer to the question.	Students can apply a model or identify changes through comparison.
Level 1	Students can carry out comparisons within a given question with given units, given variables and given material.	Students can justify their answer to the question of the comparison argumentatively.	Students can compare two or more comparison units using one variable and arrive at a meaningful answer to the question.	Students can juxtapose or rank units to compare.

content, such as inferring rules or identifying exemplary singularities. Although this competency model was developed for secondary education, it can be used as a basis to assess university students' own competency at the beginning of their initial teacher education.

Assessing students on their comparison competency also involves evaluating written texts that use comparison. How students structure their written comparisons has been

studied in discourse analysis, literacy research and language teaching. Comparison writing tasks are difficult, as the structure of the written text must lend itself to the comparative process (Englert & Hiebert, 1984; Spivey, 1991). Writing a comparison based on texts requires not only reading and selecting the information from the different texts, but also being able to reorganize it in order to carry out a comparison (Hammann & Stevens, 2003, p. 745). When provided with a comparison task, students may use one of five different organisational patterns to structure their essay (Spivey, 1991, p. 403). These patterns reflect comparison processes and structures. Students may organize the text according to comparison units (“Object format”, Spivey, 1991, p. 394), or present their results based on the variables they used (“Aspect format”, Spivey, 1991, p. 394). They can also group the results into differences and similarities (“Aspect format with Similarity-Difference Grouping”, Spivey, 1991, p. 397). The last two patterns are based on grouping variables or “Macro-Aspects” in order to organize results by object or by aspect (“Aspect format with Macro-Aspects” or “Object Format with Macro-Aspects”, Spivey, 1991, p. 397). In her study with university students, Spivey found that the “Macro-Aspect format” was the most efficient for presenting comparisons (1991, p. 409).

However, there is no research on how students make comparisons in geography education and which strategies they use to structure their results. We do not know how comparison competency relates to the strategies and text structures adopted by students when writing geographical comparisons. This study seeks therefore to conduct an exploratory analysis of how university students structure their answers when provided with a comparative task in geography education and attempts to correlate texts structures with comparison competency. The test of our assessment tool can thus help to identify the best writing strategies for the development of the comparison competency and thus validate or refine the tool as a possible scaffold for the enhancement of this competency.

## Methods

### *Test task creation*

Since comparison competency implies performance in all four dimensions of the competency model (Simon & Budke, 2020, p. 5, see Table 1) while requiring higher-order thinking and argumentation, designing a test to assess it is crucial. Any evaluation tool must be able to assess each of the different dimensions in order to provide a complete picture of students’ competency. It also must be based on a task that gives students the possibility to perform a complex comparison.

Since many textbook tasks are closed, reproductive and oriented towards content (Simon et al., 2020), they often fail to enhance comparison competency (Simon & Budke, 2020). For this reason, we designed an original task. We chose an open formulation of the task which allowed for diversity in possible answers and therefore diversity in levels of comparison competency.

We chose migration, a typical geographical topic, as the general subject of the comparison for our test of the assessment tool. Five different authentic migrant testimonies (respectively consisting of 213, 342, 434, 275 and 408 words) were collected and added to the test as possible material for the students to use. Recurring themes and possible comparison variables were: reasons to migrate, integration and mobility

patterns. As the testimonies were provided to the students as is (although two texts were shortened to stay in proportion with other examples), the texts were not symmetrical in their structure, requiring students to select and analyse the different elements in order to be able to organize their comparison.

The task is presented as: “Perform a comparison of migration stories, based on your personal knowledge and/or one or more of the following texts.”

Students had one A4 page to provide an answer. It was expected that the answer would be given in essay form, since this format is helpful for assessing students’ skills in argumentation (Budke et al., 2010, p. 66; Paniagua et al., 2019, p. 111). Moreover, essays are a good means of capturing students’ reasoning, since comparison is a complex process requiring different steps and reflection (Wilcke & Budke, 2019) and the comparison results can be structured in various ways (Spivey, 1991, p. 403).

### ***Test implementation and sample***

To test the assessment tool, we recruited bachelor students from a university seminar at the Institute for Geography Education, University of Cologne, Germany. Seventeen students enrolled in geography teacher training courses participated, taking the test during a one-hour online class in April 2021. No prior information had been given on the purpose of the test. Of these students (3 male, 13 female, 1 undisclosed), 6 were in their first semester, 8 in their second semester, 2 in the third semester and only one student was in ninth semester: we were thus able to evaluate comparison competency chiefly at the beginning of their geographical and didactical training. Tests were anonymized for analysis.

### ***Comparison texts’ assessment tool development***

In order to evaluate the essays written by the group of prospective teachers, we built a tool consisting of two parts. In the first part we took into account every dimension of the comparison competency model (Simon & Budke, 2020, p. 5, see Table 1). Each dimension was reduced to smaller evaluation items that were graded 0 if absent and 1 if present in the students’ essays. After a first round of grading with these items, we noted that students had chosen elements of the comparison process without explicitly stating their choice. Also, some students mentioned comparison elements without drawing any conclusions from the comparison. Therefore, new coding rules were formulated by the judges and new grading items were added. We added items aimed at measuring whether or not the comparison was effectively carried out, and if a conclusion was drawn. We differentiated between explicit and implicit selection of comparison elements. We also added items evaluating the pertinence of argumentation to better evaluate performance on the second dimension (reflection and argumentative justification of comparison processes, see Table 1). Finally, items in the fourth dimension (achievement of comparison objectives, see Table 1), which are noncumulative, were coded 0, 1, 2, 3 or 4 to better capture the increase in competency.

Table 2 presents all obtained items from the first part of the assessment tool at the end of the development. In this first part, students could obtain a maximum of 28 points.



**Table 2.** Comparison text assessment tool (part 1): list of categories to measure comparison competency in relation to the dimensions of comparative competency (Simon & Budke, 2020, p. 5, see Table 1). Own elaboration.

N°	PART 1: Categories to measure comparison competency	Corresponding dimension from the comparison competency model	Possible points
1	Elements of a comparison (units and variables) are set in relation to each other in order to carry out a comparison	1	0 or 1
2	The question is implicitly or explicitly chosen	1	0 or 1 (implicitly) or 2 (explicitly)
3	Variables are implicitly or explicitly chosen	1	0 or 1 (implicitly) or 2 (explicitly)
4	Units are implicitly or explicitly chosen	1	0 or 1 (implicitly) or 2 (explicitly)
5	Material is implicitly or explicitly chosen	1	0 or 1 (implicitly) or 2 (explicitly)
6	The result of the comparison is justified argumentatively	2	0 or 1
7	The argumentative justification for the results of the comparison is successful	2	0 or 1
8	The chosen question is justified argumentatively	2	0 or 1
9	The argumentative justification for the choice of the question is successful	2	0 or 1
10	Chosen units are justified argumentatively	2	0 or 1
11	The argumentative justification for the choice of the units is successful	2	0 or 1
12	Chosen variables are justified argumentatively	2	0 or 1
13	The argumentative justification for the choice of the variables is successful	2	0 or 1
14	Chosen material is justified argumentatively	2	0 or 1
15	The argumentative justification for the choice of the material is successful	2	0 or 1
16	A result to the comparison is provided	3	0 or 1
17	Comparison is made with more than 1 variable	3	0 or 1
18	Comparison is made with more than 2 units	3	0 or 1
19	Variables are weighted	3	0 or 1
20	Underlying geographical concepts are reflected with the weighting of variables	3	0 or 1
21	Comparison is used to juxtapose or rank units along the variables	4	0 or 1
22	Comparison is used to test a rule/model or show change	4	0 or 2
23	Comparison is used to question a rule/model or define a process	4	0 or 3
24	Comparison is used to formulate a rule/model or highlight the particularity of examples	4	0 or 4
<i>TOTAL</i>			<i>Max. 28 points</i>

The second part of our assessment tool (see Table 3) was built to assess students' strategies for structuring their texts since this has been related to higher text quality (Kellogg, 1987). The first author carried out a categorization through an inductive analysis of the structuring elements observed in texts, which was then confirmed by a group of other scientists. As there is currently no common scientific method for assessing comparison texts (Hammann & Stevens, 2003, p. 741), we also used elements from Spivey (1991, pp. 394–397), Englert and Hiebert (1984, p. 65) and scoring scales

**Table 3.** Comparison text assessment tool (part 2): list of categories to assess comparison text structures. Own elaboration.

N°	PART 2: Categories to analyse comparison text structures	POINTS
	(1) <i>General form of the answer</i>	0–3 points
1	Written answer was made in form of a text	Yes = 3
	Written answer was made in another form (e.g. table)	Yes = 1
		No = 0
	(2) <i>Text structure</i>	0–8 points
2	Presence of an introduction	Yes = 1
		No = 0
3	The text is organized	Yes = 3
4	• in different parts clearly identified	Yes = 2
5	• in parts less clearly readable	Yes = 1
	• poorly (low readability of structure)	No = 0
6	Presence of a conclusion	Yes = 1
		No = 0
7	Comparison cue words are used (i.e.: “likewise”, “in contrast to”)	Yes = 1
		No = 0
	<b>TOTAL</b>	<b>Max. 9 points</b>

**Table 4.** Categories for the explorative analysis of comparison structures. Own elaboration.

Types of text structures
Type 1: Text organized by comparison units
Type 2: Text organized by comparison variables
Type 3: Text organized by similarities and differences
Type 4: Text organized by thematic categories of variables but presented unit by unit
Type 5: Text organized by thematic categories of variables
Type 6: Mixed organization alternating presenting units and explaining similarities/differences

from Hammann and Stevens (2003, pp. 755–756), applied deductively to the written answers. With this scale, comparison texts could reach a maximum of 9 points.

The first categories (“General form of the answer”, see Table 3) analysed this first criterion. Secondly, we assessed the use of basic structural elements, in the essay, such as introduction, body and conclusion (“Organization of the text”, see Table 3). These elements were considered necessary in order to allow readers to understand the essays. In this section we also checked for structuring cue words specific to comparison text structures (Englert & Hiebert, 1984, p. 65).

While assessing structuring elements we also explored the variety of structures in comparison texts qualitatively. Six possible text structures for comparisons were identified. Five types were deductively identified based on Spivey’s analyses (1991, p. 397) and one mixed type present in our corpus was inductively constituted as a category (see Table 4). These text structures were analysed in an explorative way to analyse which types were used in our corpus and if a certain type of text structure tended to perform better than other types.

### **Validity and reliability of the assessment tool**

The final stage of the development of our assessment tool was to test its validity and reliability.

Validity ensures that the assessment tool really assesses the investigated concepts. Here we examined face and construct validity (Oluwatayo, 2012; Roid, 2006). Face

validity was achieved because our test used a geographical subject prone to comparison analysis, that is, migration, and offered an open task allowing a wide range of possible responses. We also ensured construct validity as we developed the first part of the assessment tool on a pretested and theoretically founded comparison competency model (Simon & Budke, 2020, p. 5), and the second part was based on already available scales (Englert & Hiebert, 1984, p. 65; Hammann & Stevens, 2003, pp. 755–756; Spivey, 1991, pp. 394–397).

Reliability means both the test and assessment can be replicated. Here we ensured the reliability of the first part by having two judges grade all tests three times, each time separated by periods of two weeks, while honing the description of the categories to ensure homogenous grading. A final grading was carried out after three months. We calculated intercoder reliability on 100% of tests and obtained a final Kappa coefficient of .72, which is considered good or substantial (Landis & Koch, 1977, p. 165). All remaining rating differences were discussed among the two judges and a common agreement was reached. The second part of the tool was tested for reliability on 100% of tests via an intracoder analysis after two rounds of grading separated by three weeks. We obtained a Kappa coefficient of .922, which is considered as perfect (Landis & Koch, 1977, p. 165).

### *Quantitative analysis of test results through descriptive statistics and correlations*

After grading all texts, we carried out different descriptive analyses to see how competent students were at comparing, using Part 1 of our assessment (see Table 2). Each student's performance could be assigned to different levels within our competency model. Other descriptive statistics were performed on the results from Part 2 (see Table 3) and on the different types of text structures found in our corpus. Finally, we calculated correlations between the two parts (see Tables 2 and 3) to identify the relationship between comparison competency and the quality of comparison text structures.

## **Results**

### *Overall results in comparison competency (part 1)*

First, during the grading of tests students obtained results of between 7 and 14 points out of a total maximum of 28 points in Part 1 of the test. The distribution of test results showed a concentration of grades in low levels of comparison competency with a mean of 10.76 points and a median of 10 points (see Figure 1). All respondents performed a comparison (item 1). 16 students wrote essays which included a result (item 16). One student provided only a table. Only four students attained half of the possible total points (28). No correlation was found between scores and gender; nor between scores and the number of completed semesters studying geography at university.

### *Results in the four dimensions of comparison competency*

To better understand the overall low results in comparison competency, students' essays were classified into the different dimensions of the competency model (Simon & Budke, 2020, p. 5, see Table 1). Results are presented in Figure 2.

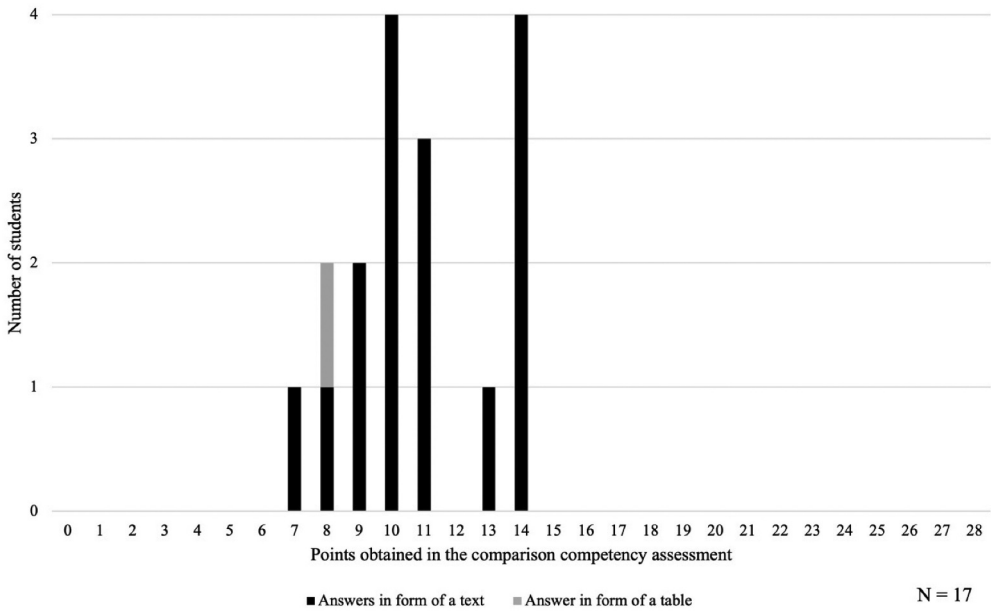


Figure 1. Distribution of points in the comparison competency assessment. Own elaboration.

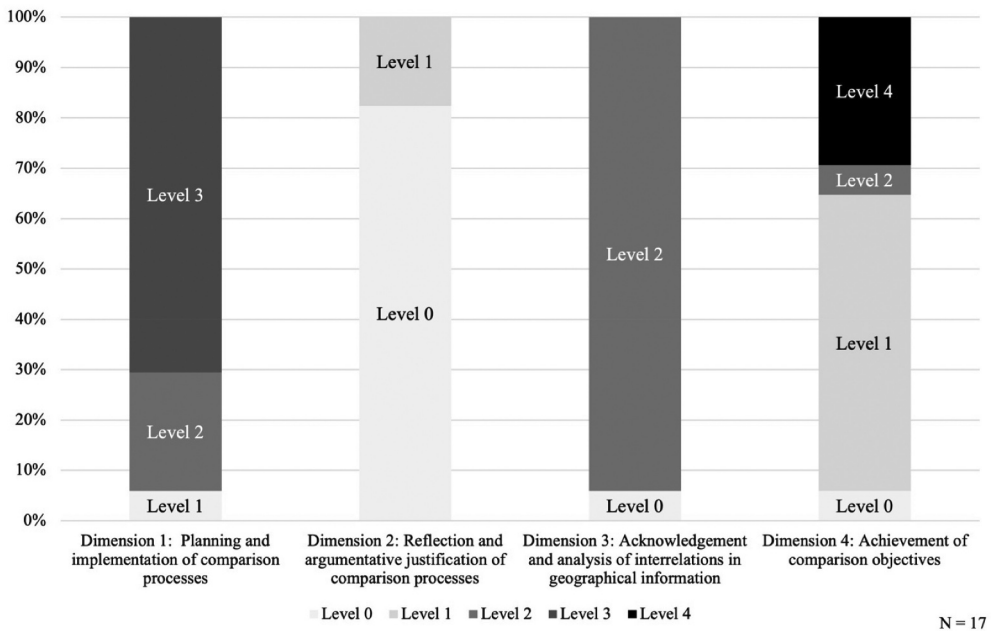


Figure 2. Students' results in the four dimensions of comparison competency. The higher the level, the higher the comparison competency. Own elaboration.

Results in the first dimension of comparison competency (Planning and implementation of comparison processes, see [Figure 2](#)) showed a substantial level in this dimension since 70.59% of students (12 out of 17) achieved level 3. As we used a very open question to test their autonomy, students were not guided in the choice of different elements of comparison and did autonomously choose comparison units, comparison variables and material. However, many did not explicitly explain the choice of these elements in the comparison process. No student chose a question to solve. Even if 88.23% of students (15 out of 17) did explicitly mention the comparison units, only 11.76% (2 students out of 17) mentioned explicitly the comparison variables they used for their comparison. Therefore, examples reflecting on comparison variables such as the following, were rare: “*One can compare [the stories] in very different ways. For example, you [can] first look at the motive of the people (. . .). You can look at their flight and their prospects on the country they now live in (. . .). You can also look at their experiences in the country of origin (. . .) and whether they want to go back*” (Extract from Student n°9. Translated from German. Emphasis added).

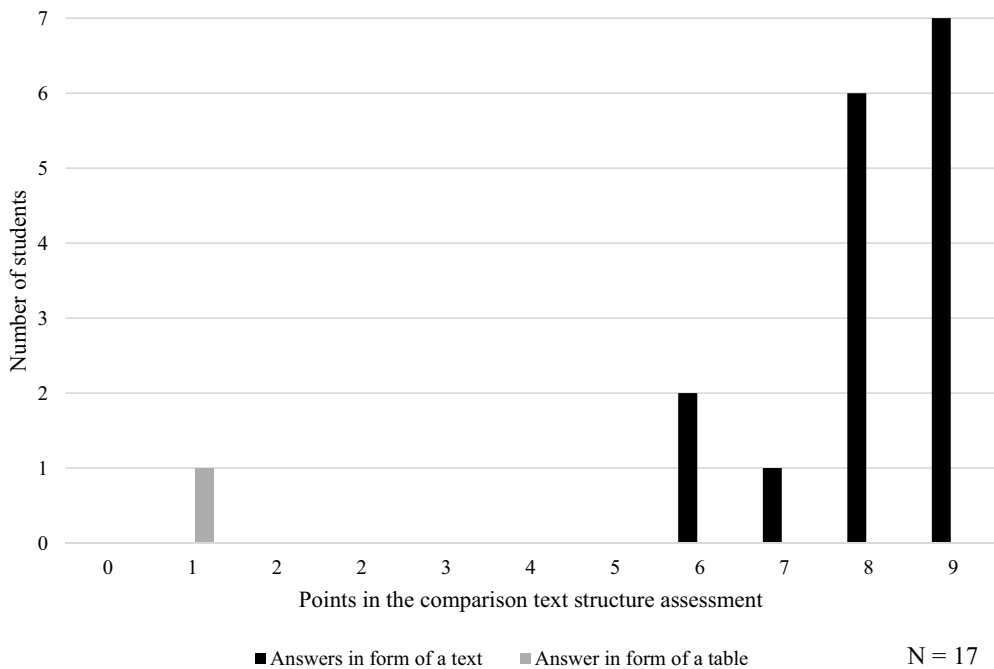
Results in the second dimension of comparison competency (Reflection and argumentative justification of comparison processes, see [Figure 2](#)) showed very little use of argumentation to support the comparison process, with only 17.65% of students (3 out of 17) attaining level 1 in this dimension while using argumentation to justify their results. Students did not provide arguments to justify their choice of comparison elements. Few students cited source texts while performing their comparison, with only one referring explicitly to precise lines to prove their conclusions.

In dimension 3 of comparative competency (Acknowledgement and analysis of interrelations in geographical information, see [Figure 2](#)), results showed a moderate competency: 94.12% (16 students out of 17) obtained level 2 while using more than one variable to analyse two units or more. But, these results also confirmed that students did not reflect on the different variables and their respective weight (level 3) to explain their results. They did not reflect on the concepts via the weighting of variables (level 4). This shows that their choice of variables was arbitrary and not guided by any question to solve.

Finally, results showed that students performed better in the fourth dimension of comparison competency (Achievement of comparison objectives, see [Figure 1](#)). Although one student did not reach any level, competency was more distributed in this dimension: 58.82% (10 out of 17 students) obtained level 1, by using comparison to simply state similarities or differences. One student (5.88%) obtained level 2 and used comparison to show a process or test a rule. 29.42% (5 students out of 17) attained level 4 and performed complex comparisons, identifying specificities or building rules in an inductive way. For example, a student wrote: “*One can **conclude** that [migrants’] plans sometimes (have to) change: migration stories are sometimes not linear*” (Extract from Student n°6. Translated from German. Emphasis added).

### **Results in comparison text structures’ assessment (part 2)**

Students’ performance in the comparison text structure analysis (Part 2) is presented in [Figure 3](#).



**Figure 3.** Distribution of points in comparison text structure assessment. Own elaboration.

Results were grouped around a mean of 7.71 and a median of 8 out of a maximum of 9 points. One of the respondent's written answers was awarded only one point, since it was given in form of a table juxtaposing variables and units without drawing any conclusion from the comparison nor providing any explanation (item 1, see Table 3). No text obtained less than half of all possible points. All written texts obtained good results since they were all structured, with 81.2% of texts (13 out of 16 texts) including an introduction, 75% of texts (12 texts) being clearly organized, and 10 texts (62.5%) including a conclusion (items 2–6, see Table 3).

### *Results in the use of comparison text types*

To analyse the text structures, six categories were constituted (see Methods): five were deductively constituted from the literature review (Spivey, 1991) and another one constituted as an inductive category in our corpus (see Table 4 and Figure 4).

Out of the six identified text structures (see Table 4 and Figure 4), students used only three different strategies to write their comparison. The most common strategy was Type 1 ("Text organized through comparison units", see Figure 4) with 7 out of 16 texts (43.75%) using this structure. These texts used cue words to compare and contrast the source material. For example, after presenting the first migrant's story in a paragraph, a student began the following paragraph thus: "**In contrast to this story** [from a refugee], *the woman did not have to flee because she want[ed] to leave the country voluntarily. Her circumstances [we]re not as tragic and urgent as in [the first story]*" (Extract from Student n°17. Translated from German. Emphasis added).



Figure 4. Types of comparison text structures (inductive-deductive categorization using observed texts and Spivey (1991)). Own elaboration.

The second most used strategy, adopted in 31.25% of texts (5 students out of 16 using a text), was variable oriented (Type 2, “Text organized through comparison variables”, see Figure 4). Finally, 4 students out of 16 (25% of texts) chose a mixed organization for their texts (Type 6, “Mixed organization alternating presenting units and explaining similarities/differences”, see Figure 4). No student chose to group variables into clusters (Types 4 “Text organized by thematic categories of variables but presented unit by unit” and 5 “Text organized by thematic categories of variables”, see Figure 4) and no text was organized solely around similarities/differences (Type 3, “Text organized by similarities and differences”, see Figure 4).

### *Correlations between strategies and performance*

We calculated a correlation between scores from the two parts of the assessment tool (Part 1: comparison competency assessment and Part 2: comparison text structure assessment, see Tables 2 and 3) to evaluate to what extent structuring strategies could correlate to different levels in comparison competency. Total results in each part of the assessment were found to be moderately positively correlated,  $r(15) = .533, p = .02$ . The better structured the comparison was, the more competent students were while comparing. This positive relationship between both parts of the assessment may mean that the use of structured answers reflects better competency, but could also indicate that using structured answers allowed respondents to develop better comparison competency. Thus, we can not only suppose that a lack of comparison competency can lead to difficulties in structuring answers, but also, that problems with strategy and structure during a written task indicate difficulties mastering comparison processes.

We also looked at the mean results of the first assessment tool (see Table 2) in relation to the different text structure strategies (see Table 3). Results showed that best scores were obtained by students adopting a Type 1 structure (“Text organized through comparison units”, see Figure 4) with a mean of 10.28 points whereas texts structured around variables (Type 2 “Text organized through comparison variables”, see Figure 4) obtained a mean of 9.2 points and mixed structures (Type 6, “Mixed organization”, see Figure 4) obtained a mean of 8.5 points. Given the small sample size, we could not test the significance of these differences; but it seems that the choice of a clear writing strategy rather than a mixed organization (Types 1 or 2 against Type 6, see Figure 4) could have an influence on comparison performance.

### **Discussion**

Comparison is an important competency in geography and a common task which is often performed by students throughout their geography education in secondary school and at universities. In this study we aimed to develop an assessment tool evaluating comparison competency and comparison text structures, to explore students’ comparison competencies and to relate them to their writing strategies. Our aim was also that the assessment instrument could be used as a scaffold to develop comparison competency.

First, we developed a valid and reliable assessment tool. Not only was the validity of the comparison competency assessment confirmed, since it was built on a previously validated comparison competency model, but our results also agreed with those of



previous research (Simon & Budke, 2020; Simon et al., 2020), notably regarding students' poor performances regarding argumentation (Budke & Kuckuck, 2017, p. 101; Budke et al., 2010, p. 68; Uhlenwinkel, 2015, p. 56). Therefore, this assessment tool can assess students' comparison competency and writing strategies in comparison texts. It can be used in future research and by university programs to assess students' comparison competency.

Secondly, we wanted to identify difficulties students face in comparison tasks and where they lack competency. Our results indicated that the prospective geography teachers from our sample showed only low levels of comparison competency. This aligns with our research analysing textbooks, which showed that textbook comparison tasks do not enhance the development of comparison competencies (Simon & Budke, 2020; Simon et al., 2020). Without meaningful textbook comparison tasks to train their comparison skills during their secondary education, our geography students tended to achieve only low levels of comparison competency. Many of them were still in the first semesters of their studies, so the influence of secondary teaching was presumably still predominant in their answers. Results from the classification of students in the first dimension of comparison competency (Planning and implementation of comparison processes, see Table 1 and Figure 2) showed that many students did not explicitly select comparison elements such as units or variables. Although the open task design allowed them to autonomously select different comparison elements, they did not master the comparison method and did not perform this task consciously or reflect on their selection. This shows that designing open tasks is necessary to enhance autonomy in the comparative process, but also that the comparison process and identification of comparison elements need to be learnt and practiced to ensure students master this dimension. Results were also poor in the second and third dimensions of comparative competency (Reflection and argumentative justification of comparison processes and Acknowledgement and analysis of interrelations in geographical information, see Table 1 and Figure 2). Not being familiar with the comparison method and accustomed to very closed tasks, as our textbook analysis shows (Simon & Budke, 2020; Simon et al., 2020), students did not associate comparison with argumentation and did not reflect on the comparison process. These poor results in the second dimension relative to argumentation are in line with the results of previous studies where students' argumentation skills were found to be very low (Budke & Kuckuck, 2017, p. 101; Budke et al., 2010, p. 68; Uhlenwinkel, 2015, p. 55), moreover in classroom environments where argumentation is not frequent (Driver et al., 2000, p. 308; Kuhn & Crowell, 2011, p. 551). However, students' results were better in dimension 4 (Achievement of comparison objectives, see Table 1 and Figure 2). This is again in accordance with our initial analysis of textbook tasks which showed that textbook tasks performed better in the fourth dimension of comparison competency (Simon & Budke, 2020; Simon et al., 2020). Students' improved performances in the fourth dimension may be due to the fact that they learned how to formulate rules via comparison processes during secondary education. They were presumably trained in this dimension of comparison competency.

As a consequence, a combination of open tasks and tools that help elucidate comparison process, such as comparison matrices and detailed instructions (e.g. Englert et al., 1991), can be of use in fostering comparison competency in students. It is also necessary to make students aware of the different steps and requirements of the comparison

method: although comparing is a fundamental cognitive activity (Goldstone et al., 2010, p. 103), it is not an easy task to perform. Therefore, teaching a conscious approach to comparison processes seems necessary to enhance comparison competency in geography students and prospective teachers. It is also necessary for students to understand why argumentation is necessary to comparison processes and why it can help develop comparison competency and therefore scientific geographical literacy, since argumentation skills are related to scientific reasoning (e.g. Kuhn, 1992, p. 144; Zohar & Nemet, 2002, p. 58). The assessment tool presented in this study can itself be used as such a scaffold to teach students how to perform comparison processes and reflect them argumentatively.

Thirdly, our study explored how students structured their comparison texts and aimed to investigate how writing strategies were related to comparison competency. Only 3 different text structures were used by our students: Types 1 (Text organized by comparison units), 2 (Text organized by comparison variables), and 6 (Mixed organization alternating presenting units and similarities/differences, see Figure 4). This is an interesting finding, since there is no common accepted method of structuring written comparisons in geography and a variety of structures were expected (see Figure 4). Although Spivey (1991) identified the “Macro-Aspect Structure” (Type 5 in our assessment, see Figure 4) as the best structure for comparison, it was not used by our students. In their study, Kirkpatrick and Klein (2009, p. 318) also found that students rarely organized their texts according to specific comparison elements, such as variables or similarities and differences. Students in their study and in a study by Englert et al. (1988, p. 44) also structured their texts according to units (Type 1). However, as students were not trained to structure their texts in a particular way beforehand, we can suppose that they chose presentation by units as the most convenient structure. Presenting the comparison unit by unit was certainly the easiest strategy for students, since they simply had to follow the order of units as they appeared in the source materials and did not need to develop a plan in order to write their text. However, it may not be the most efficient way to structure comparisons.

The Type 6 writing strategy (Mixed organization alternating presenting units and similarities/differences, see Figure 4) is a common strategy used in German secondary education (e.g. Becker-Mrotzek et al., 2015). In the Abitur<sup>1</sup> examination, different subjects such as Geography or German are assessed through so-called “material-based writing”, in which students are supposed to write their own text based on various documents such as maps, statistical tables and texts. The answer is thus often broken down into a first section summarizing the documents, then a second section discussing the relationships between them. The Type 6 text structure identified in our corpus is an example of this structure applied to geography education (Budke et al., 2021, p. 156). The fact that students used this mixed structure in their answers demonstrates that they used secondary education strategies to solve the task. This strategy to structure comparison may be singular to German students. However, this shows the necessity to consider local specificities or practices in the evaluation of comparison texts.

The results of the comparison competency assessment and the comparison text structure assessment were positively correlated. Either structured texts showed better comparison competency, or a better comparison competency implied better text structuring skills. This can be explained by the fact that writing a comparison implies specific

text structures pertinent to the peculiarities of comparison: students need to be aware of comparison's fundamental structures such as comparison units, variables, similarities and differences, as Hammann and Stevens (2003, p. 733) also showed. This is also in line with findings from Englert et al. (1988, p. 42) which correlated students' writing performance with students' understanding of the utility of writing strategies.

Students using Types 1 and 2 as comparison text structures did better than students using the Type 6 mixed organization. Using the Type 6 structure may have led students to forget about comparison structuring elements such as variables, which were necessary for better performance. We can also suppose that students using the variable structure (Type 2) were more challenged by this text organization (Spivey, 1991) and therefore performed worse than students juxtaposing and alternating units (Type 1) which appeared to be easier for them (Englert et al., 1988, p. 44; Kirkpatrick & Klein, 2009, p. 318). Type 2 texts organized around variables are more difficult to write since they imply careful preparation and combining elements from different sources in a non-linear reading. There is, therefore, a need for didactic tools to teach specific comparison text structures around variables or clusters of variables (Types 2, 4 and 5) in geography education. University programs aiming to better train comparison competency need to include reflection on comparison text structures and writing tools as a means to enhance this competency.

Our assessment tool to measure comparison competency is not only a measurement tool: it is also a potential useful scaffold to teach comparison. Gibbons has identified different steps for scaffolding: first, scaffolding means evaluating the "demands of the particular subject content" and second, the "learning needs of the learners" (Gibbons, 2002, p. 218), before educators design specific and appropriate material to help learners (third step). Here educators can use the assessment tool to diagnose comparison competency and measure each student's "zone of proximal development" (Vygotsky, 1978, p. 37). Then, depending on the students' initial competency, the assessment tool can be didactically adapted to allow them achieve progressively greater competency while selecting needed items to be trained by students. When full competency is achieved, students shall be able to compare autonomously without needing the tool. It is also possible to introduce the tool so that students use it as they need it or adapt it as their own scaffold (Holton & Clarke, 2006, p. 136) to gain agency in their own learning processes.

## **Conclusion**

Teaching fundamental geographical methods such as comparison in higher education implies the ability to assess students' competency. It is also necessary to reflect on possible tools to be provided to prospective teachers who will have to teach this competency to secondary education students. In this study, we developed an assessment tool for comparison competency. We found that comparison competency in prospective teachers appears to be underdeveloped. Their lack of autonomy in comparison processes calls for increased focus on teaching geographical comparison in higher education. The comparison process should be explicitly taught so that students can compare consciously and explicitly in order to better develop their skills. Using the assessment tool presented in this study as a scaffolding tool is a way to achieve this objective since our tool allows to train comparison competency in small steps and to gain help with comparison text

structures. This seems crucial in order to help future geography teachers not only to master an essential geographical method, but also to be able to teach this competency to their own future students.

## Note

1. *Abitur*: German examination at the end of secondary education.

## Acknowledgements

The authors would like to thank Prof. Dr. Frank Schäbitz for his support and Michelle Wegener for her help in the overarching project.

## Disclosure statement

No potential conflict of interest was reported by the authors.

## Funding

This research was funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation)–Project Number 57444011–SFB 806.

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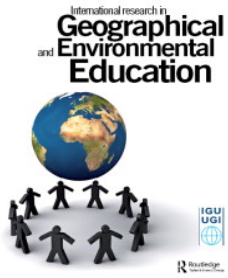
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#### **4.4 Study 4: An intervention study: teaching the comparison method to enhance secondary students' comparison competency**

**Citation:** Simon, M., & Budke, A. (2024a). An intervention study: Teaching the comparison method to enhance secondary students' comparison competency. *International Research in Geographical and Environmental Education*, 33(1), 72–89.

<https://doi.org/10.1080/10382046.2023.2214039>



# International Research in Geographical and Environmental Education

ISSN: (Print) (Online) Journal homepage: [www.tandfonline.com/journals/rgee20](http://www.tandfonline.com/journals/rgee20)

## An intervention study: teaching the comparison method to enhance secondary students' comparison competency

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**To cite this article:** Marine Simon & Alexandra Budke (2024) An intervention study: teaching the comparison method to enhance secondary students' comparison competency, *International Research in Geographical and Environmental Education*, 33:1, 72-89, DOI: [10.1080/10382046.2023.2214039](https://doi.org/10.1080/10382046.2023.2214039)

**To link to this article:** <https://doi.org/10.1080/10382046.2023.2214039>



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# An intervention study: teaching the comparison method to enhance secondary students' comparison competency

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## ABSTRACT

To tackle the growing challenges facing our societies, such as climate change, we need to understand scientific knowledge and methods. Developing scientific literacy in schools is therefore necessary. To do so, we need to be able to assess competencies associated with scientific literacy. Secondly, educators need meaningful tools which can be implemented in geography classes. One important competency students learn in geography is comparison. Although students perform comparisons in geography classes regularly, we do not know their level of comparison competency. Research is also needed on potential tools to teach the comparison method efficiently in geography classes. Therefore, in this study, we assessed the comparison competency of 83 French and German secondary students and tested a tool to enhance comparison competency in an intervention study using a pre- and post-test control group design. Results indicate that students initially possessed low levels of comparison competency. Our intervention allowed students from the experimental group to improve their comparison skills significantly. The improvement in their post-test scores was positively correlated with the use of the comparison method during the intervention. This shows that teachers should include explicit instructions on the comparison method to help students develop their scientific literacy.

## KEYWORDS

assessment in geography education; comparison competency; intervention study; scientific literacy

## Introduction

Our societies face many challenges today: climate change, the COVID-19 pandemic, the growing world population and more. These issues give rise to much debate and are sometimes appropriated for political ends. To understand them and to consider solutions, scientific knowledge and knowledge of the scientific method are essential. Therefore, developing scientific literacy is one of the most important educational challenges today, since it can enable students to understand the debates and act in

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consequence. Scientific literacy; the ability to think critically and understand scientific issues, has been long identified as crucial (OECD, 2019). Scientific literacy is a key competency (Rychen & Salganik, 2001, p. 16) that encompasses not only the content knowledge related to scientific questions but also procedural and epistemic knowledge about how science is practised and how scientific knowledge is produced (OECD, 2019, p. 99). This also includes critical perspectives on science practices and a deep understanding of the strengths and limitations of science. To reinforce scientific literacy, scientific methods must be practised and taught in schools and students' competencies related to scientific methods need to be assessed. This is also true for the science of geography (Chang & Kidman, 2019).

Comparison is one of the most important scientific methods (Piovani & Krawczyk, 2017, p. 822). It is used, for example, in urban studies and geography. Comparison is used to generalize or theorize from cases (Krehl & Weck, 2020, p. 1867), to build models, to reflect on processes or on the specificity of examples through contrasting (Nijman, 2007, p. 4). Understanding how the comparison method is used by geographers can help students critically reflect on comparisons that are made in other contexts, for example in recent debates around the consequences of climate change or migration in different contexts.

Comparisons are frequently referred to in geography curricula (e.g. in France: Ministère de l'Éducation Nationale et de la jeunesse, 2020, p. 2; in Germany: DGfG, 2017). Comparison tasks are also common (9.18%) tasks in geography textbooks (Simon, Budke, & Schäbitz, 2020, p. 6). Comparison as one of the common geographical cognitive demands in geography education (Bourke & Lane, 2017) is therefore also one of the geographical skills secondary students need to learn.

However, there is no assessment of secondary students' levels of comparison competency. Neither do we know how to reinforce comparison competency and thus teach comparison competency as a part of scientific literacy. In recent years, various authors have identified the need for research related to assessment of students' learning in geography education (Kidman & Chang, 2022; Lane & Bourke, 2019). Educators lack instruments assessing key geographical skills (Lane & Bourke, 2019, p. 11; Bourke & Lane, 2017), although some tests were developed, for example to assess spatial thinking (Bednarz & Lee, 2019). Research is also needed to know what teaching tools are effective to improve geographical education (Kidman & Chang, 2022, p. 170) and how formative and summative assessment can be integrated (Bourke & Mills, 2022, p. 17). Therefore, we designed an intervention study involving French and German secondary students in which we assessed their competency and tested a tool to enhance it. Whereas differences between German and French students will be analyzed in another article, in this paper, we will investigate the following research questions:

1. How competent are secondary students in the different dimensions of comparison competency?
2. To what extent does the use of the comparison method applied in the intervention have an impact on students' comparison competency?

This article begins with the theoretical framework used as a basis for the intervention (Theoretical background). This is followed by a description of the test and

of the intervention (Methods). The results section presents the test results and effects of the intervention (Results). Then, we discuss the implications for the enhancement of comparison competency (Discussion).

## Theoretical background

### *Comparison competency*

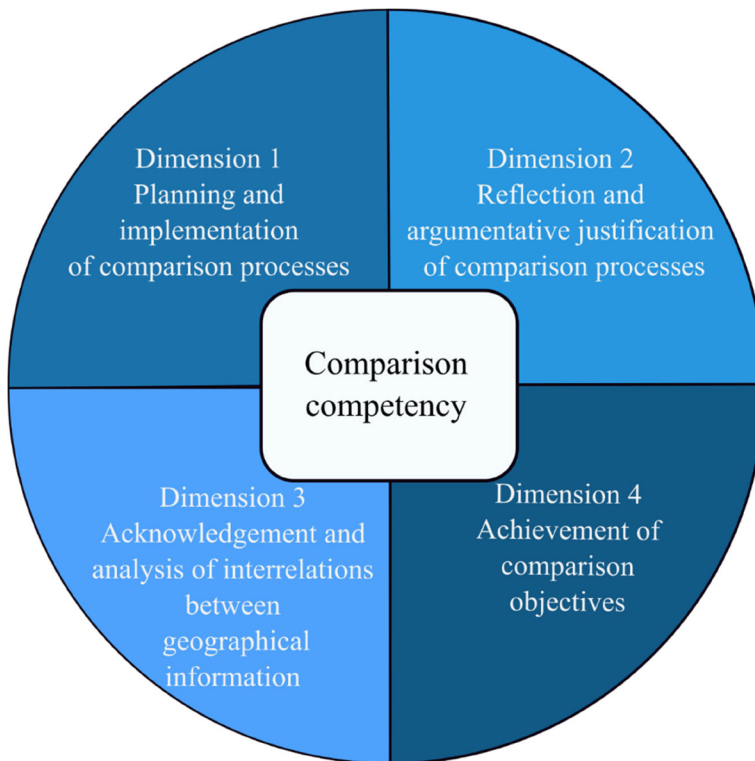
To compare means to select comparison units (i.e. countries or migration routes) and juxtapose them with comparison variables (criteria such as economic growth or obstacles to migrants) to identify similarities and/or differences (Namy & Gentner, 2002, p. 6). Comparison is a fundamental tool of human reasoning which allows us to draw general conclusions from specific observations (Gick & Holyoak, 1983, p. 31), and to apply those to new examples (Loewenstein & Gentner, 2001, p. 211). It is also one of the fundamental modes of spatial thinking identified by Gersmehl and Gersmehl (2007, p. 184).

Comparison is also a research tool widely used in the social and natural sciences to build rules (Lijphart, 1971, p. 691) or identify specific peculiarities (Piovani & Krawczyk, 2017, p. 3). Geographers too use comparison as an important research strategy to investigate geographical spaces and build theory or analyze local variations (Kantor & Savitch, 2005). The objectives and methodology of geographic comparisons are much discussed in the scientific community. For example, the scientific debate on the definition of a “global city” (Sassen, 1999; Robinson, 2006) revolves around the possibility to formulate general characteristics for a group of cities based on the comparison of specific examples. The comparison methodology itself often “remains implicit” (Krehl & Weck, 2020, p. 1858) and there is no common model for the comparison method among geographers. This shows how comparison is a dynamic and diverse research tool: the way comparisons are made has theoretical and epistemological implications.

Only in geography education research did Wilcke and Budke (2019, p. 7) model the comparison process. Their model allows for a wide variety of comparisons and can serve as a first step to teach this complex method. In this model, first, students have to decide on a specific question to be resolved with the comparison. Second, they select comparison units and variables. Then, they identify similarities and differences and provide an answer to the initial question, while weighting variables and deriving explanations. Each step of this method shall ideally be reflected and justified.

Comparison in geography education can be therefore defined as an important competency which students need to master and which encompasses four specific dimensions (see [Figure 1](#)).

First, comparison requires the ability to formulate a geographical question, to autonomously choose the data that serve as a basis for comparison, and to select comparison units and variables, following the comparison process described by Wilcke and Budke (2019) (“First dimension: planning and implementation of comparison processes,” see [Figure 1](#)). Secondly, comparing involves the ability to reflect on the comparison process and justify the selection of comparison elements (“Second



**Figure 1.** Competency model for comparison in geography education (further explained and detailed in Simon & Budke, 2020, p. 5). Own elaboration.

dimension: reflection and argumentative justification of comparison processes,” see Figure 1). Thirdly, comparison requires the ability to recognise and analyse how comparison variables differently impact comparison units (“Third dimension: acknowledgement and analysis of interrelations between geographical information,” see Figure 1). Finally, students must be able to achieve comparison goals, such as inferring rules or identifying the specificity of given examples (“Fourth dimension: achievement of comparison objectives,” see Figure 1).

Applying the comparison competency model to French, German and English geography textbook tasks enabled us to demonstrate that comparison tasks mainly served content-related purposes and did not foster scientific reasoning and argumentation skills (Simon et al., 2020; Simon & Budke, 2020). In another study, most German university students in geography did not display high levels of comparison competency and many of them were not able to structure their comparison texts in effective ways (Simon & Budke, 2023). Their competency levels were especially low in the first, second and third dimensions of comparison competency (Figure 1). However, we do not know how competent students from secondary schools are at performing comparisons. This study thus aims to provide an explorative assessment of comparison skills of secondary students in Germany and France.

## ***Interventions to foster geographical skills***

In the *Road map for twenty-first century geography education*, Bednarz, Heffron, and Huynh (2013, p. 8) described the need to investigate the “characteristics of effective geography teaching.” One way to implement this research objective is to carry out intervention studies in experimental or quasi-experimental conditions. Intervention studies in geography are, however, rather scarce (Abricot, Zuniga, Valencia-Castaneda, & Miranda-Arredondo, 2022) and often focus on two geographical competencies: systems thinking (e.g. Cox, Elen, & Steegen, 2019) and spatial thinking (e.g. Lee & Bednarz, 2012). To date, no intervention study has examined how to promote comparison competency in geography education. Yet, this is crucial if we want to enhance geographical and scientific literacy while teaching geographical methods such as comparison in secondary education.

Furthermore, interventions can help us understand which tools are more efficient for teaching a scientific method. Scientific methods and scientific literacy are often observed to be better assimilated when accompanied by argumentation to build evidence-based arguments or to justify and reflect along the scientific process (Cavagnetto, 2010; Jimenez-Aleixandre & Erduran, 2007). Indeed, scientific methods such as comparison are much more complex than just following specific steps like a kind of recipe. For example, comparison requires intense reflection on comparison variables, comparison units and the relative weight of comparison elements, meaning students must be able to use arguments to support the comparison process (Wilcke & Budke, 2019). Cavagnetto (2010, p. 10–13) describes different approaches, or orientations, used in argument-based interventions aiming to foster scientific literacy and identifies an immersive approach as the best strategy for teaching argumentation. Cox et al. (2019) stressed the importance of explicit teaching strategies as decisive for the success of classroom interventions. As no intervention has been designed to date to foster comparison competency, there is no research on which tools are valuable for fostering comparison competency. Therefore, we conducted an intervention study in which we used the comparison method explicitly as a scaffold (Vygotsky, 1978) to foster the development of comparison competency. Our design uses a “mixed” approach (Cavagnetto, 2010, p. 11) taking elements from the “structured” method firstly (learning explicitly the structure of comparison) and immersion in a research situation secondly.

## **Methods**

To investigate our research questions, we led a quasi-experimental intervention study with a pre- and post-test control group design.

## **Sample**

83 students from two secondary schools, two classes in Germany and two classes in France, participated in this study. There were 44 students in the experimental group (29 French, 15 German) and 39 in the control group (31 French, 8 German). Since

the quasi-experimental design was subject to reduced internal validity due to the non-randomized group attribution of participants, we controlled for socio-demographical variables such as school results, age, and former geographical education since students were enrolled in similar school forms with both French and German experimental groups enrolled in specialized geography classes.<sup>1</sup> We also realized a t-test on the results of the pre-test to ensure the possibility of regrouping students from France and Germany<sup>2</sup>: in both intervention and control groups, results showed that they were not significantly different from each other (experimental group:  $t(42) = 1.604$ ,  $p = .116$ , two-tailed; control group:  $t(37) = 1.302$ ,  $p = .201$ , two-tailed). The intervention took place in October 2021 in Germany and in December 2021 in France. Students from both groups took the pre-and post-tests just before and after the intervention. Students and parents were previously informed of the study to which they consented. All tests and data were anonymized for analysis.

### **Pre-and post-tests**

Since textbook comparison tasks often only require students to simply reproduce information, they do not allow us to assess competency in all dimensions of our competency model (Simon & Budke, 2020). Therefore, we formulated an open task (see [Box 1](#)) that allowed for varied answers and enabled us to assess different levels of comparison competency. To complete the test students could use different migration stories provided to them in the test form. Students had one A4 page to provide an answer which was expected to be given in essay form, to be able to assess students' skills in argumentation (Paniagua, Swygert, & Downing, 2019, p. 111) and knowledge of comparison processes (Wilcke & Budke, 2019, p. 8).

**Box 1. Task for the assessment of comparative competencies (pre-test). Own elaboration.**

"Perform a comparison of migration stories, based on your personal knowledge and/or one or more of the following texts."

The post-test was based on the same principles as the pre-test but the subject was changed to control for former subject knowledge and concentrate only on comparison competency. Therefore, in the post-test, we collected testimonies about different housing situations in big cities which students had to compare. The task from the post-test is presented in [Box 2](#).

**Box 2. Task for the assessment of comparative competencies (post-test). Own elaboration.**

"Perform a comparison of housing situations in big cities, based on your personal knowledge and/or one or more of the following texts."

Both the pre-and post-test were rated using our already reliable and validated assessment tool which allows us to analyse students' achievements in the different dimensions of comparison competency (Simon & Budke, accepted, see [Table 1](#)).

To ensure the reliability of our scoring, we calculated inter-rater agreement on 50% of German tests and intra-rater reliability on 25% of French tests (with a 2

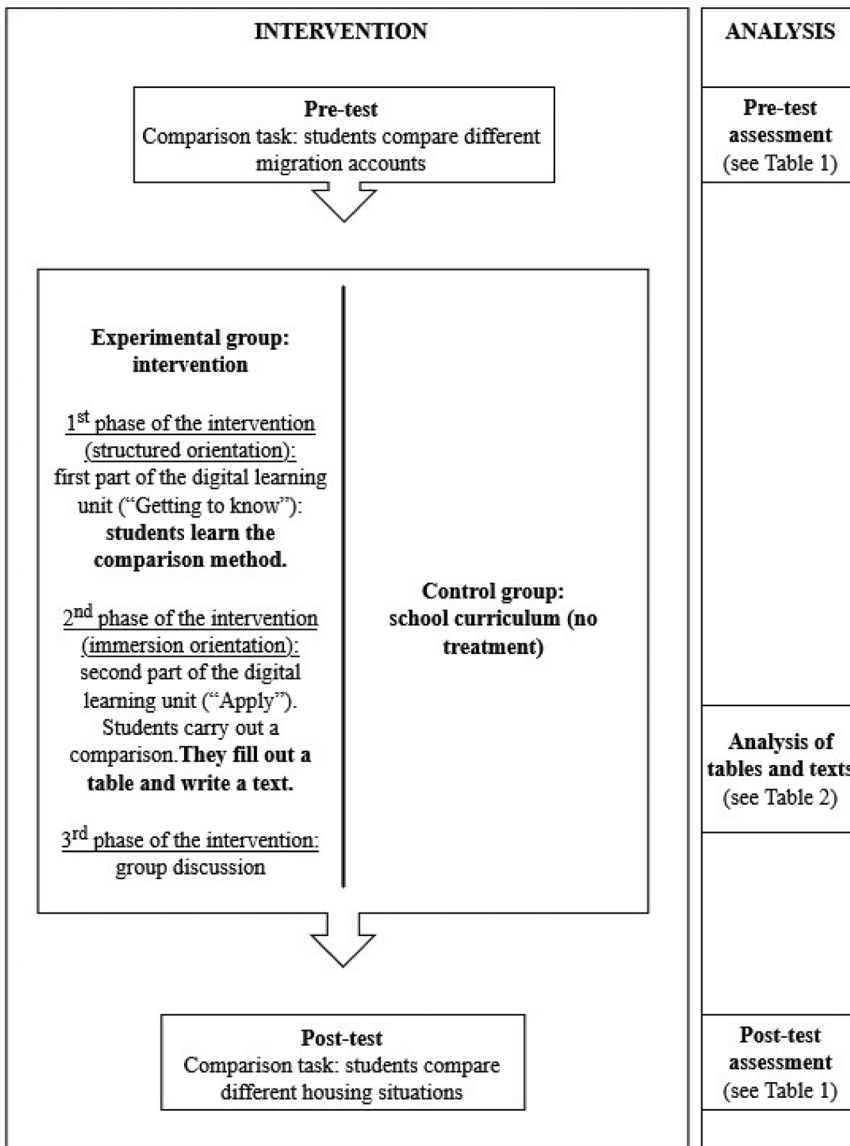
**Table 1.** Comparison competency assessment: list of categories to measure comparison competency (Simon & Budke, 2020, p. 5, see table 1). Own elaboration.

Categories to measure comparison competency	Possible points
Elements of a comparison (units and variables) are set in relation to each other in order to carry out a comparison	0 or 1
The question is implicitly or explicitly chosen	0 or 1 (implicitly) or 2 (explicitly)
Variables are implicitly or explicitly chosen	0 or 1 (implicitly) or 2 (explicitly)
Units are implicitly or explicitly chosen	0 or 1 (implicitly) or 2 (explicitly)
Material is implicitly or explicitly chosen	0 or 1 (implicitly) or 2 (explicitly)
The result of the comparison is justified argumentatively	0 or 1
The argumentative justification for the results of the comparison is successful	0 or 1
The chosen question is justified argumentatively	0 or 1
The argumentative justification for the choice of the question is successful	0 or 1
Chosen units are justified argumentatively	0 or 1
The argumentative justification for the choice of the units is successful	0 or 1
Chosen variables are justified argumentatively	0 or 1
The argumentative justification for the choice of the variables is successful	0 or 1
Chosen material is justified argumentatively	0 or 1
The argumentative justification for the choice of the material is successful	0 or 1
A result of the comparison is provided	0 or 1
Comparison is made with more than 1 variable	0 or 1
Comparison is made with more than 2 units	0 or 1
Variables are weighted	0 or 1
Underlying geographical concepts are reflected with the weighting of variables	0 or 1
Comparison is used to juxtapose or rank units along the variables	0 or 1
Comparison is used to test a rule/model or show change	0 or 2
Comparison is used to question a rule/model or define a process	0 or 3
Comparison is used to formulate a rule/model or highlight the particularity of examples	0 or 4
<b>TOTAL</b>	<i>Max. 28 points</i>

monthly interval between ratings). We obtained a percent agreement between judges of 93.5% and a Cohen's Kappa of .837 on German tests and a percent agreement of 95.7% and a Cohen's Kappa of .905 on French tests which is considered almost perfect (Landis & Koch, 1977, p. 165).

### **Intervention**

After both groups took the pre-test, students in the experimental group were taught an intervention course during 6 classes of 45 min each while students from the control group did not receive any treatment. We decided not to intervene on the regular curriculum of the control group, first, because the subject-specific topic used in the intervention was not assessed in the post-test and second, because we could then compare our intervention involving explicit instruction with the regular curriculum. The intervention was based on a digital learning unit<sup>3</sup> available as an Open Educational Resource. All documents, videos, maps, texts and interviews of this digital learning unit were developed in collaboration with scientists from the Collaborative Research Center CRC-806.<sup>4</sup> These documents on past migration were juxtaposed with documents and sources on recent migration. Students could choose between different questions related to migration such as reasons for migration, migration routes, research on migration or obstacles to migration. [Figure 2](#) gives an overview of the intervention.



**Figure 2.** Overview of the interventional study and different analyses. Own elaboration.

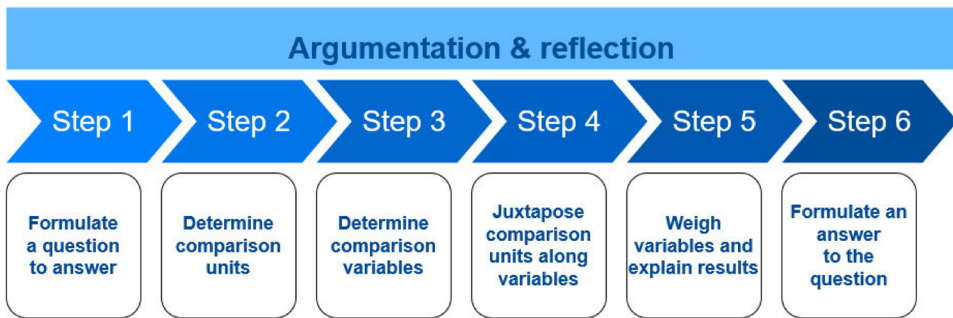
### ***First phase of the intervention***

In the first phase, students followed instructions on the digital learning unit which allowed them to get to know the comparison elements (variables, units) and the different comparison steps (see Figure 3). The comparison method presented in this part was based on the model by Wilcke and Budke (2019) adapted to be the main teaching tool used during the intervention to train comparison competency.

### ***Second phase of the intervention: written comparison task (table and text)***

To apply the comparison method learnt in the first phase, in the second phase of the intervention students had to carry out a comparison. The comparison process





**Figure 3.** Comparison steps as provided to students during the intervention. Translated from German. Own elaboration.

**Table 2.** Assessment tool to evaluate subtasks corresponding to comparison steps (based on Figure 1). Own elaboration.

Comparison steps and tasks	Possible points
Step 1: formulate a question	0 or 1
Step 2: determine comparison units	0 or 1
Step 3: determine comparison variables and material used	0 or 1
Step 4: juxtapose comparison units according to comparison variables	0 or 1
Step 5: weigh comparison variables and explain results	0 or 1
Step 6: formulate an answer to the question	0 or 1
Transversal task: justify and argue on each step of the comparison process (choice of units, variables, material and justification of results)	0 - 4

was divided into steps which were directly identified in the digital learning unit and corresponded to the different steps of the comparison method (see Figure 3). Each step was to be justified using arguments. To complete the task, students were provided with a table,<sup>5</sup> which was used along with the comparison method as a scaffold to guide students in the investigative decision-making process involved in the comparison and enhance their justification of the comparison process. While comparison units were given (recent and past migrations), the task was formulated very openly, contrary to existing textbook tasks which are often very closed in their formulation (Simon et al., 2020). It allowed for great autonomy in the choice of the comparison question and comparison variables. Many different elements could be found in very diverse documents. For example, to answer the question on the comparison of migratory routes between Africa and Europe used in past and in recent migrations, students could consult different maps, texts and a film but also add detail to their answers by consulting the texts on the obstacles to migration. Students had to write a text summarizing their findings. We analysed students' individual answers (table and text) to the task, assessing if they had properly implemented the steps of the comparison method (Steps 1 to 6, see Table 2). Moreover, we checked if they had properly explained their decisions and/or results in the different steps (for example, justifying results or the choice of variables) (transversal task, see Table 2). This allowed us to rate students on a scale of 10 points to evaluate the implementation of the method as a didactic tool.

These first and second phases of the intervention were designed to allow students to learn and practice autonomously selecting comparison elements, justifying their choices and reflecting on the weighting of variables and on the comparison contexts.

### ***Third phase: group discussions***

In the third phase, group discussions were organized. Participants had to compare their approaches with those of other students and defend their own ideas through argumentation. This phase reinforced the use of the comparison method as a tool, while revising comparison elements and process.

### ***Quantitative analysis***

Descriptive statistics were performed on the pre-and post-tests to assign the performance of each student to different levels within the competency model. We analyzed groups' performances and progress between pre and post-test using t-tests and a one-way analysis of covariance with pre-tests used as a covariate (ANCOVA).

Results obtained during the intervention (see [Table 2](#)) were also correlated to the difference between scores in pre-and post-tests.

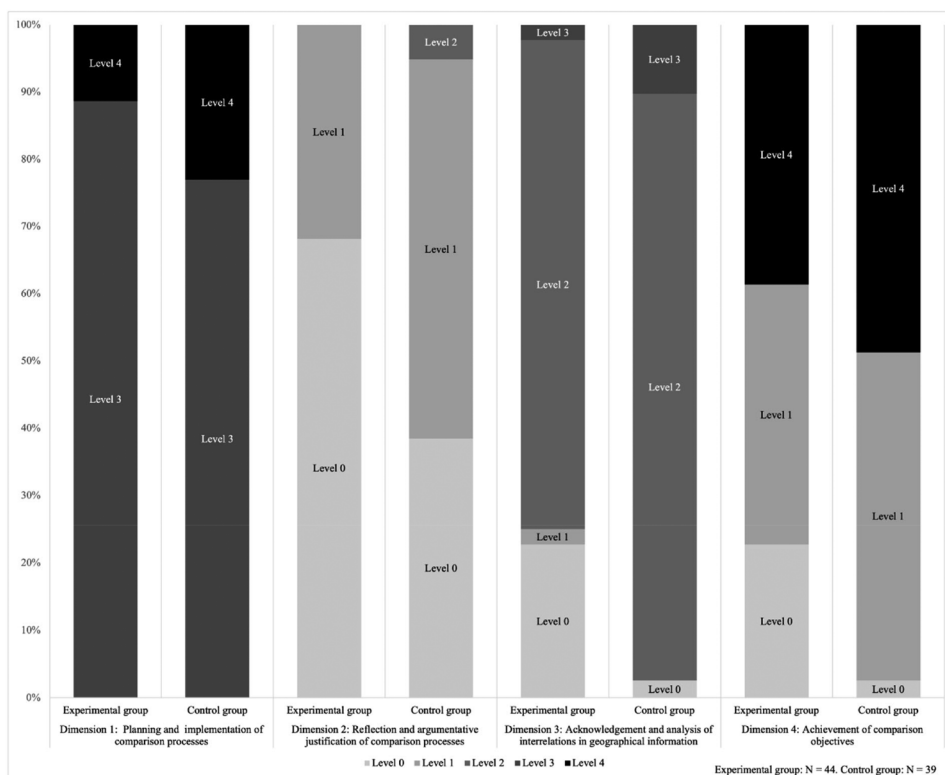
Finally, the results of the experimental group in the post-test were compared to results obtained in a previous study of university students' comparison competency (Simon & Budke, 2023). Since the assumption of homogeneity of variances was violated, a Welch's t-test was used.

## **Results**

### ***Secondary students' comparison competency: results of the pre-test***

The pre-test was designed to gain insight into existing comparison competencies and to uncover any possible differences between the experimental and the control group. The experimental group obtained out of 28 possible points a mean of  $10.05 \pm 2.96$  whereas the control group achieved a higher score of  $11.51 \pm 2.427$ . Comparison competency in the two groups was thus quite low since they attained under half of the maximum possible points. The difference between groups was significant ( $t(81) = 2.448$ ,  $p = .017$ , two-tailed). This can be explained by the fact that groups were not randomized. Both teachers also explained that students from both control groups had generally better grades than those from the experimental groups. As a consequence, we used then the pre-test as a covariate in all analyses to control for this fact. We also correlated the personal data of participants to control for other possible covariates but no significant relation was found between the pre-test results and other variables such as gender or age. We classified both groups' results in the different dimensions of the comparison competency model (Simon & Budke, 2020, p. 5) (see [Figure 4](#)).

Results in the first dimension of comparison competency (Planning and implementation of comparison processes, see [Figure 4](#)) showed good levels since 88.64% of students in the experimental group and 75.92% in the control group achieved level 3. But, students mainly did not explicitly select their comparison elements. Only 4.54% of students from the experimental group and 7.69% from the control group explicitly chose a question to answer, and only 6.82% of the experimental group and 10.26% of the control group explicitly chose comparison variables.



**Figure 4.** Results obtained in the pre-test by both the experimental and the control group in the different dimensions of comparison competency. The higher the level, the higher the competency. Own elaboration.

Comparison units, on the contrary, were often cited (90.9% of students from the experimental group, and 89.74% of the control group).

Results in the second dimension of comparison competency (Reflection and argumentative justification of comparison processes, see Figure 4) showed that argumentation did not support the comparison process in most tests, with only 31.82% and 56.41% of students respectively from the experimental and the control group attaining level 1 in this dimension. Only two students (5.13%) of the control group attained level 2 in this dimension while justifying their choice of comparison units.

In dimension 3 of our competency model (Acknowledgement and analysis of interrelations in geographical information, see Figure 4), 72.73% in the experimental group and 87.18% in the control group achieved level 2. This was mainly due to the fact that they used more than one variable to compare the units. Level 3, a more complex level of this dimension, at which students must be able to weigh variables, was only obtained by one student from the experimental group and 4 students from the control group (10.26%).

Results in dimension 4 of comparison competency (Achievement of comparison objectives, see Figure 4) were better since 38.64% in the experimental and 48.72% of students in the control group achieved level 4. However, 22.72% of the experimental group and one student in the control group did not achieve any objective

with their comparison since they only juxtaposed comparison units along variables without stating if comparison units were different or similar. Also, no student achieved level 2 or level 3. 38.64% of students in the experimental group and 48.72% in the control group achieved only level 1.

Overall, the results of the pre-test showed rather low levels of comparison competency in both groups in dimensions 2 and 3 of comparison competency related to argumentation and interrelations between comparison elements. Relatively higher levels were found in dimensions 1 and 4 related to comparison processes and comparison objectives.

### Effects of the intervention

To calculate the effects of the intervention, scores and net differences of the control group and of the experimental group in pre-and post-tests were calculated. Results are presented in table 3.

To ascertain if the differences between pre-and post-test scores were significant in both groups, we performed t-tests on paired samples. When considering assumptions for the calculation of the t-test, we found only light outliers so we decided not to exclude them from our data. In both groups, the differences between the pre-and post-test scores were not normally distributed, as shown by the Shapiro-Wilk test (control group:  $p = .022$ ; experimental group:  $p = .005$ ). However, since our samples were reasonably large ( $N > 30$ ), we also proceeded further with the analysis (Stone, 2010, p. 1563). In the experimental group, post-test scores were significantly higher than pre-test scores,  $t(43) = 4.069$ ,  $p < .001$  (two-tailed),  $d = .613$ . In the control group, post-test scores were significantly lower than pre-test scores:  $t(38) = -3.810$ ,  $p < .001$  (two-tailed),  $d = .61$ . In both groups, the differences were significant with medium effect sizes (Cohen, 1988).

To confirm that the intervention had an impact on scores, we performed an ANCOVA with pre-test scores entered as a covariate (Dugard & Todman, 1995). The homogeneity of regression slopes was respected with regard to the dependent variable, as the interaction terms were not statistically significant ( $p = .152$ ). The residuals were normally distributed, as stated by the Shapiro-Wilk test,  $p = .175$ . However, three light outliers were found and the homogeneity of variance was not satisfied, as the Levene's test showed ( $p = .022$ ). Outliers were identified as the highest achievers in the post-test with scores of 19 points (out of 28 possible points). They only stood out by one point as compared to the next highest achieving students (18 points). Therefore, after careful consideration, we included their results in the calculations

**Table 3.** Descriptive statistics of results from both groups in the pre- and post-test. Own elaboration.

	Experimental group (N=44)			Control group (N=39)		
	Mean	% of total score	Standard deviation	Mean	% of total score	Standard deviation
Pre-test	10.05	35.89%	2.965	11.51	41.11%	2.427
Post-test	12.68	45.28%	3.916	10.03	35.82%	2.915
Net difference ((post-test) - (pre-test))	2.64	9.43%		-1.49	-5.32%	

and went forward with the ANCOVA. The calculation showed that after adjusting for the pre-test, post-test results differed significantly in the two groups,  $F(1, 80) = 20.258$ ,  $p < .001$ , partial  $\eta^2 = .202$ . This confirmed that the intervention had a positive impact on the comparison competency of the experimental group.

### ***The influence of the implementation of the comparison method on comparison competency***

Finally, we investigated whether or not scores in the implementation of the comparison method (see Table 2) could be linked to the difference between pre-and post-tests scores in the experimental group. Results showed that there was an almost strong (Cohen, 1988) positive correlation between both elements  $r = .470$ ,  $p = .001$ . We can then suppose that the observed progress between pre-and post-test in this group was correlated to the systematic use of the teaching tool presenting the comparison method (see Figure 3).

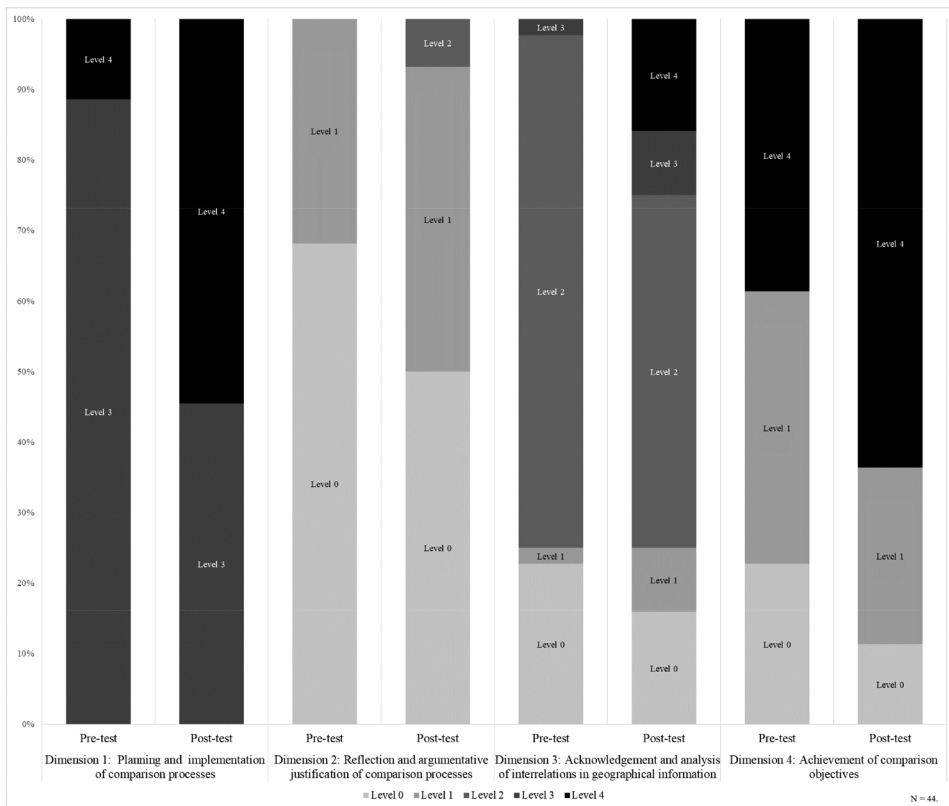
When classifying the results of the experimental group in the post-test into the different dimensions of comparison competency, we could observe that all dimensions of comparison competency improved between tests (see Figure 5).

In Dimension 1 (“Planning and implementation of comparison processes,” see Figure 5), 54.5% of students achieved level 4 while 45.5% achieved level 3. This showed that more students chose all elements of the comparison process in the post-test than in the pre-test, including a question to answer with the comparison. In dimension 2 (“Reflection and argumentative justification of comparison processes,” see Figure 5) there was also an improvement in the use of argumentation not only to justify their answers (from 31.8% in the pre-test to 43.18% in the post-test thus obtaining level 1 in this dimension), but also to justify the choice of comparison elements (6.82% of students in the post-test obtaining then level 2). In Dimension 3 (“Acknowledgement and analysis of interrelations in geographical information,” see Figure 5), higher levels were also achieved, with 15.91% of students obtaining level 4, while none had achieved this level in the pre-test. Finally, students also performed better in dimension 4 (“Achievement of comparison objectives,” see Figure 5) where level 4 was achieved by 63.64% of students (in the pre-test, only 38.64% of students obtained this level).

Overall, the intervention and the use of the comparative method as a tool had a positive impact on post-test scores and on comparative competency in the experimental group. When compared to pre-test results of first-year students (a mean of  $10.82 \pm 2.29$ ) in our previous study which used the same assessment tool (Simon & Budke, 2023), the results in the post-test (a mean of  $12.68 \pm 3.92$ ) of secondary students were significantly better (95% - CI [.22, 3.49]),  $t(49.07) = 2.28$ ,  $p = .026$ .

## **Discussion**

In this study, we conducted an intervention study with 83 secondary students from France and Germany using a quasi-experimental design and provided a first assessment of how competent secondary students are at performing a comparison. We



**Figure 5.** Results obtained by the experimental group in the pre- and post-tests in the different dimensions of comparison competency. The higher the level, the higher the competency. Own elaboration.

also tested the use of the comparison method to reinforce comparison competency. This first assessment of secondary students' comparison competency and test of a tool to enhance it provides an initial response to calls for more research in the area of assessing and enhancing geographical skills (Bourke & Mills, 2022; Kidman & Chang, 2022; Lane & Bourke, 2019).

Results showed that most secondary students in our study mastered only low levels of comparison competency before the intervention. In the pre-test, students did not reflect on the comparison process while selecting comparison elements. Many students did not use argumentation to justify their decisions in the comparison process. These initial results align with our previous research on textbook tasks. Textbook comparison tasks often fail to foster the development of comparison competencies since they do not enhance higher-order thinking and only focus on comparison results (Simon et al., 2020; Simon & Budke, 2020), which can explain the low levels achieved in the pre-test. Secondary students' argumentative skills were also found to be insufficient in various studies (Budke, Schiefele, & Uhlenwinkel, 2010, p. 68; Uhlenwinkel, 2015, p. 59). The better results found in the fourth dimension of comparison competency ("Achievement of comparison objectives," see Figure 4) are also in accordance with our initial analysis of textbook tasks which showed that textbook tasks performed

better in this dimension (Simon et al., 2020; Simon & Budke, 2020). Students were able to achieve higher results, since they had already been confronted with tasks that enhance this dimension of comparison competency.

Our intervention proved that enhancing the comparison competency of secondary students is possible *via* the explicit communication of the comparison method - as a tool in the first phase of the intervention and as a prompt in the teaching instructions to build a comparison during the immersion in a research situation phase - (see Figure 3). Although Cavagnetto (2010 p. 15) described the “immersion” intervention as the best intervention form for developing argumentation, in our study, the mixed organisation (first, the explicit teaching of the comparison method and then immersion in an research situation using the method) was proven to be valuable. This aligns with other studies where explicit teaching strategies were successful at enhancing skills such as system thinking (e.g. Cox et al., 2019). Indeed, in our study, explicitly teaching the different steps of the comparison method and using the method throughout the implementation phase allowed the competency to be reinforced, since we correlated the use of the method to progress between pre-and post-tests. This enabled all dimensions of comparison competency to be bolstered, since we could see improvements in both the methodological dimensions (dimensions 1 and 2) and the content-related dimensions (dimensions 3 and 4) of comparison competency. This suggests a possible interdependency between progress in methodological and content-related dimensions of comparison competency and points to the success of explicit instruction in metacognitive strategies teaching the students how to learn.

Finally, in the results of the experimental group, secondary students from German and French high schools (“*Gymnasium*” and “*lycée*”) in the post-test showed a significant increase in comparison competency, which allowed them to perform better than university students evaluated without the teaching intervention (Simon & Budke, 2023). This demonstrates the great potential of the explicit teaching and use of the comparison method in geography classes in secondary education to reinforce comparison competency. Although the intervention was successful, we did not test its efficacy in the long term even if the post-test showed that students could transfer the generic model to other comparison tasks. Further research could assess if progressive teaching of the comparison method, used regularly as a scaffold (Vygotsky, 1978) during secondary education, would ensure that the progress made by secondary students would last. Also, since the comparison method was used as a basis for the assessment tool development (Simon & Budke, 2020, 2023; see Table 1), our results suggest that providing the students with the assessment tool (or parts of it) would allow them to assess their own progress and the assessment tool to be both summative and formative. More generally, teaching geographical methods in secondary education should be implemented more to prepare students for university and to enforce scientific literacy.

## Notes

1. In Germany, all participants from the experimental group were enrolled in an advanced elective geography class: “Leistungskurs Geographie”. In France participants were enrolled in the history-geography, geopolitics and political sciences stream: “Spécialité Histoire-géographie, géopolitique, sciences politiques”.

2. Differences between the two countries will be explored in another article.
3. Link to the digital learning unit in German: [https://www.ilias.uni-koeln.de/ilias/goto\\_uk\\_lm\\_4325913.html](https://www.ilias.uni-koeln.de/ilias/goto_uk_lm_4325913.html). In French: [https://www.ilias.uni-koeln.de/ilias/goto\\_uk\\_lm\\_4391846.html](https://www.ilias.uni-koeln.de/ilias/goto_uk_lm_4391846.html). In English: [https://www.ilias.uni-koeln.de/ilias/goto\\_uk\\_lm\\_4911773.html](https://www.ilias.uni-koeln.de/ilias/goto_uk_lm_4911773.html).
4. The CRC-806 “Our way to Europe” was funded in three phases from 2009 to 2021. In this interdisciplinary project, archaeologists, climate researchers, geoscientists, etc. explored factors, obstacles and possible routes for human dispersal from Africa to Europe. It involved our project which aimed to disseminate research results while doing educational research. More information can be found here: <https://www.sfb806.uni-koeln.de/>
5. The table and instructions for students can be found on the following pages of the digital learning unit: [https://www.ilias.uni-koeln.de/ilias/ilias.php?ref\\_id=4325913&obj\\_id=350011&cmd=layout&cmdClass=ilImpresentationgui&cmdNode=hb&baseClass=ilLMPresentationGUI](https://www.ilias.uni-koeln.de/ilias/ilias.php?ref_id=4325913&obj_id=350011&cmd=layout&cmdClass=ilImpresentationgui&cmdNode=hb&baseClass=ilLMPresentationGUI)

## Acknowledgements

The authors would like to thank Prof. Dr. Frank Schäbitz for his support, Michelle Wegener, and students and teachers who participated in the study for their collaboration.

## Disclosure statement

The authors declare no conflict of interest.

## Funding

This research was funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation)–Project Number 57444011–SFB806. The digital learning unit (OER) was funded by the Bundesministerium für Bildung und Forschung (BMBF, Federal Ministry of Education and Research) in the DiGeo project under the funding code 16DHB3003.

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#### **4.5 Study 5: German and French students' strategies while performing geographical comparisons in a group task setting**

**Citation :** Simon, M., & Budke, A. (2023). German and French Students' Strategies While Performing Geographical Comparisons in a Group Task Setting. *Education Sciences*, 13 (8), 849. <https://doi.org/10.3390/educsci13080849>

Article

# German and French Students' Strategies While Performing Geographical Comparisons in a Group Task Setting

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**Abstract:** Today's challenges, such as climate change, require developing geographical literacy, which includes discussion and argumentation around scientific results. One important geographical method and competency is comparison. However, learning geographical methods, such as comparison, can be a challenge for students if they rarely solve open tasks that do not require simple answers. In this study, we analysed group discussions that took place during an intervention, aiming to develop comparison competency with 44 German and French students from the experimental group. Through the use of the documentary method, students' main orientations and strategies to solve the open comparison tasks were reconstructed. We related the implementation of the comparison method during group discussions to students' individual progress during the intervention and explored differences between French and German students. Results show that students' main task completion orientation was challenged by their uncertainty towards the comparison task. Groups developed strategies to solve the task, showing, in a few cases, competency acquisition processes. Only a few differences were found between German and French students. Overall, implementing scientific literacy means to operate a shift in task culture at schools towards more open tasks aiming to enhance geographical competencies and argumentation.

**Keywords:** comparison competency; geographical literacy; group discussions; documentary method



**Citation:** Simon, M.; Budke, A. German and French Students' Strategies While Performing Geographical Comparisons in a Group Task Setting. *Educ. Sci.* **2023**, *13*, 849. <https://doi.org/10.3390/educsci13080849>

Academic Editor: Robyn M. Gillies

Received: 11 July 2023

Revised: 14 August 2023

Accepted: 18 August 2023

Published: 20 August 2023



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## 1. Introduction

In a rapidly changing world, facing important challenges such as climate change or the consequences of the COVID-19 pandemic calls for more science education (in both the natural and social sciences). There is a need to form “scientifically informed” students able to act and exert their agency to build a more sustainable future (e.g., [1], pp. 5–6). Scientific literacy—one's ability to understand scientific issues and how science is produced while thinking critically about it [2] (p. 16)—is therefore a fundamental competency to be able to tackle future challenges and has long been identified as such [3,4]. Recent analyses emphasize the collective dimension of scientific literacy and of agency [1] (p. 12), i.e., responses to the aforementioned societal challenges are to be discussed and found collectively. Therefore, both educational contexts and geography education are a pivot to enhance scientific literacy and discussion around intrinsically geographical challenges, and therefore need a deeper understanding of geographical methods.

One of the most important research methods in the natural and social sciences is comparison [5], which is, for example, used by geographers to interpret and understand similarities and differences between geographical places. Mastering comparison is essential to understand “big” geographical questions [6] (p. 307). It can help understand, for example, how climate change differently affects geographical places depending on different criteria (for example, different vulnerabilities of natural or urban systems [7]) and how different reactions or measures (for example, a framework for urban climate resilience [8]) can have different outcomes depending on the studied places. To develop scientific (geographical)

literacy and help students understand complex challenges, enhancing key geographical methods, such as comparison, is necessary. While learning these methods, students have to understand that argumentation and reasoning are core scientific features [4] (p. 2), which means that educators have to integrate debate and discussion about scientific methods into common classroom activity. However, this can be difficult. First, on the one hand, there is school and “task” culture and, on the other hand, there are students’ patterns of action, which often lead them to look for only one “right” answer, leaving little place for uncertainty or collective debate [9]. Second, since school and academic geographies are often diverse [10,11], it becomes difficult to teach geographical thinking productively [12].

This article is part of a mixed-method study [13] implementing an embedded design. In the quantitative parent study, we led a quasi-experimental intervention with 83 German and French students (44 students in the experimental group, 39 in the control group). We tested their comparison skills and used an educational tool to enhance students’ comparison competency [14]. Results showed that although students mastered very low levels of comparison competency in the pre-test, it was possible to enhance it via the explicit teaching of the scientific method that is comparison. This article focusses on the embedded qualitative study that took place during the intervention. We analysed qualitative data obtained during group discussions within the experimental group (44 students) to better understand our quantitative results and explain the comparison competency acquisition processes. Our research questions were:

- (1) What student groups’ action-guiding orientations can be reconstructed while they perform open comparison tasks?
- (2) What strategies do German and French students adopt to solve argumentative and collaborative comparison tasks, and how do these strategies relate to individual performance regarding comparison competency during the intervention?
- (3) To which extent can we identify different action-guiding orientations or strategies between French and German students?

This article follows with a description of our theoretical basis (Section 2) and of our embedded mixed-method approach aiming to explain our quantitative results via qualitative analysis (Section 3). Then, we present the results of our analysis (Section 4), and finally, we discuss the implications for the designing of comparison tasks in geography education (Section 5).

## 2. Theoretical Background

### 2.1. Comparison: A Method and a Competency

To compare is the cognitive process of juxtaposing comparison units (for example, regions or urban areas) along comparison variables (for example, access to resources or population density) to identify similarities and/or differences [15] (p. 6). Comparison is a much used research method. It is used in the natural and social sciences to derive rules from particular examples in theory-oriented approaches [16] (p. 691), or to understand fine complexities and variations between local or specific examples in a more idiographic way [5,17,18]. In geography, comparison of places and derived explanations are at the core of the discipline: for example, Cutter et al. [6] (p. 307) identified the question “What Makes Places and Landscapes Different from One Another and Why Is This Important?” as the first “big question” there is for geographers to investigate. Morgan [19] (p. 275) also defined geographical thinking as the “trained capacity to construct a mental map to see patterns, recognise relationships, to see movement, to take that map and ‘clothe it in meaning’.” In this definition, identifying patterns means to compare geographical spaces or places. While comparing geographically, many scientific and methodological practices are possible, such as selecting a large number of comparison criteria or variables to identify types or patterns (for example, to study urban growth of global cities [20]), or exploring, qualitatively, the local specificities of a common characteristic (for example, to analyse gentrification processes [21]). Comparison objectives are also very much discussed among geographers around the question of the possibility to generalize and derive rules

from examples in a nomothetic way (e.g., [22]). Therefore, comparison is not an easy or a ready-made geographical method, because it supposes to decide carefully and being able to argue to defend not only one's own decisions while selecting comparison elements, but also the followed comparison process and obtained results. As a consequence, argumentation and reflection are at the core of the comparison method. Designing meaningful comparison tasks for geography education, while promoting the acquisition of geographical methods, such as comparison, means to guide students so that they argue and reflect on their choices.

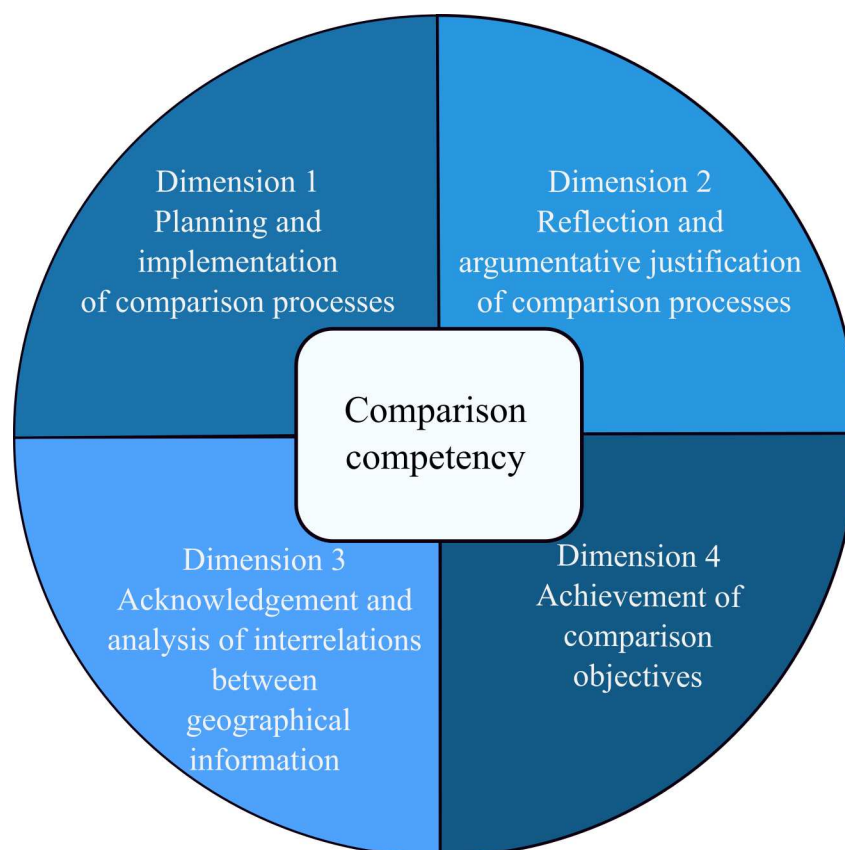
Wilcke and Budke [23] (p. 7) developed a model for the comparison method in geography education, which highlights these necessary elements such as argumentation while describing comparison as a process following different steps. In the first step, students formulate a specific question to solve with the help of the comparison (for example, to investigate reasons for how human migrations changed over time). In the second step, they choose the comparison units, such as past and recent migration waves. In the third step, students select comparison variables, such as political or economic factors, and then juxtapose these units along with the variables in the fourth step, in order to identify similarities and/or differences. Finally, students weigh the different variables and formulate an answer to their question. In this process, each step must be carefully reflected upon. Performing a comparison is therefore a complex competency that can be divided into four dimensions (see Figure 1). Comparison competency supposes to be able to, first, organize and implement comparison processes sustained by argumentation (First and Second dimensions of comparison competency: "Planning and implementation of comparison processes", and "Reflection and argumentative justification of comparison processes", see Figure 1). Along with these methodological components, there are also content-related dimensions of comparison competency (Third dimension, "Acknowledgement and analysis of interrelations between geographical information," and Fourth dimension, "Achievement of comparison objectives", see Figure 1).

To evaluate how comparison tasks allow to develop comparison competency, we led a textbook analysis showing that French, German and English textbook tasks often focus on content-related dimensions of comparison competency (Dimension 3: "Acknowledgement and analysis of interactions between geographical information", and Dimension 4: "Achievement of comparison objectives", see Figure 1). Most tasks do not allow to autonomously plan and reflect on comparison processes [24,25]. Our evaluation of university and German and French secondary students' performances, before having received training, also showed that they had very low levels of comparison competency in the second dimension (Dimension 2: "Reflection and argumentative justification of comparison processes", see Figure 1) since they recurred, only rarely, to argumentation to support their results or justify their choice of comparison elements. Overall, although argumentation and reflection are central to comparison processes, those were precisely the skills students in our two former studies lacked while answering comparison tasks [14,26]. This highlights the difficulties for students to overcome the gap between school and academic geographies [10,11] and the subsequent necessity for educators to find tools to help students to learn geographical thinking and skills [12].

## 2.2. Group Discussions to Enhance Comparison Competency Development

Since students have difficulties in the argumentative dimension of comparison competency, there is a need for educational tools and task settings that can enhance the development of comparison competency and this dimension particularly. Different authors have already called for more research on geographical skill development [27] and on "effective geography teaching" [28] (p. 8). However, there are still few intervention studies in geography education [29], and no intervention to date has integrated the teaching of the comparison method via group work settings in geography education research [29]. Interventions often focus on other competencies such as system or spatial thinking, e.g., [30,31]. In our parent study, and first quantitative part of the project, we used the comparison method as a scaffold during the individual learning phases of intervention and during

group discussions (see Materials and Methods for a description of the overarching project). Our results showed that students improved their comparison competency significantly between the pre- and post-test compared to the control group, and that the use of the comparison method [23] during the individual work phase of the intervention was positively correlated to students' progress between the two tests [14]. However, we do not know to what extent group discussions helped enhance comparison competency; thus, this study focusses on this specific part of the intervention and qualitatively analyses group discussions to evaluate their contribution to comparison competency development.



**Figure 1.** Competency model for comparison in geography education, for more details see [24] (p. 5). Own elaboration.

While in class, and also during group work, students act according to certain action-guiding orientations [32–34]. Action-guiding orientations are internalised patterns of perception, thought and action [34], *modi operandi* that guide practical action [32,33] and lead to adopt certain strategies. One important student action-guiding orientation is the “task completion orientation”, which corresponds to their “student job” oriented towards the delivery of a work product [34–36]. Luhmann [9] (pp. 77 ff.) has described this usual classroom situation in his concept of “trivialization”, which exists in schools because the knowledge to be acquired is pre-defined and a distinction is usually made between false and correct answers. However, our intervention and, specifically, the group work phase were designed to allow for very different answers to the initial task and for a variety of comparisons (as is also the case in scientific comparisons). Therefore, they did not correspond to the usual and reassuring setting of a task leading to only one “correct” answer, which is often the case in secondary [34] and geographical education, and which is also a problem in other natural sciences [4]. Since no other intervention tested a comparison task allowing for a variety of multiple answers, we do not know how students dealt with this “new” situation where they had to compare their answers and find a solution and, thus, if their possible “task completion orientation” was challenged by the task. Jiménez–

Alexandre et al. [37] also showed that concurring cultures relevant either to scientific or to school culture could be seen in group work settings with students sometimes “doing science” and sometimes “doing the lesson”. Thus, our study aims to explore which action-guiding orientations students were more drawn to while answering the group task, to better understand how these orientations could influence groups’ strategies while solving the task.

Group discussions or having to justify one’s own results in a group setting and debating to find a common answer can be a way to develop argumentative and reasoning skills [4,38,39]. Argumentation is necessary for one’s own records or reflections during the comparison process and the selection of comparison elements, such as comparison units or variables. But it is also necessary so that students can justify their results in front of other students in a group setting and in a scientific context [4]. Osborne et al. [4] showed that student argumentations were enhanced when presented with alternate ideas. Interaction and small groups also allow better outcomes to develop argumentation and scientific reasoning skills than individual learning [40–42]. However, tasks involving group discussions without scaffolds, which guide students to develop arguments, lead to very little successful argumentation [43]. Other research findings suggest that explicit prompts that encourage reasoning have positive effects on students’ argumentations [4,44]. Although we used the comparison method as a scaffold during the whole intervention, we do not know to what extent students integrated this into their strategies to solve the task, and therefore, collectively, developed their comparison competency. Strategies adopted by students engaged in group work can be very varied to finish with a common answer. Albe [45] described some of them, which were discussion, voting, collaborative argumentation, role playing and imposition of authority or acceptance of other arguments. Such group work also implies the adoption of specific roles between students who can act as “leaders” or “helpers” [45] (p. 84). This study aims to clarify what strategies were used by the groups, and which of them allowed themselves to develop comparison competency.

Overall, this study aims to qualitatively analyse students’ action-guiding orientations and strategies during the group discussions in relation to their comparison competency acquisition [46] (p. 235), and to identify possible differences between French and German students while using the reconstructive approach of the documentary method [47].

### 3. Materials and Methods

This qualitative study took place during a quasi-experimental intervention in an embedded mixed-method design [13].

#### 3.1. Previous Study Research Design

We recruited 83 students in the age range from 16 to 18 from two secondary schools, two classes in Germany (“11.Klasse”) and two classes in France (“classe de Terminale”), who constituted the 44 students of the experimental group (29 French, 15 German) and 39 of the control group (31 French, 8 German). Students from both groups took a pre- and a post-test just before and after the intervention, which took place between October and December 2021 in both countries. Both tests allowed to assess students’ comparison competency in all dimensions of the competency model (see [14,26] for more details on the assessment; see Figure 1), and we could assess that students only mastered low competency levels at the beginning of the intervention. At the end of the intervention, results revealed significant progress in comparison competency in the experimental group compared to the control group. We could also positively correlate the use of the comparison method during the intervention to the difference between post- and pre-tests: students who had used the comparison method during the intervention were those who progressed most between the tests [14].

Students from the experimental group were taught an intervention course during 6 classes of 45 min each (see Figure 2) based on a digital learning unit available as an OER (Open Educational Resource) (The digital learning unit is available in German: <https://www.oer.de/>).



[//www.ilias.uni-koeln.de/ilias/goto\\_uk\\_lm\\_4325913.html](https://www.ilias.uni-koeln.de/ilias/goto_uk_lm_4325913.html) (accessed on 19 August 2023). In French: [https://www.ilias.uni-koeln.de/ilias/goto\\_uk\\_lm\\_4391846.html](https://www.ilias.uni-koeln.de/ilias/goto_uk_lm_4391846.html) (accessed on 19 August 2023). In English: [https://www.ilias.uni-koeln.de/ilias/goto\\_uk\\_lm\\_4911773.html](https://www.ilias.uni-koeln.de/ilias/goto_uk_lm_4911773.html) (accessed on 19 August 2023)). All data used in the learning unit were developed with scientists from the Collaborative Research Center “CRC-806”, which worked on migration routes from Homo Sapiens from Africa to Europe and whose data were adapted to be taught in high schools (Scientists (archaeologists, geographers, climate scientists, anthropologists) from the CRC-806 “Our way to Europe” analysed factors, obstacles and possible routes for human dispersal from Africa to Europe. Our institute participated while adapting scientific results into school material and conducting educational research. See <https://www.sfb806.uni-koeln.de/> (accessed on 17 August 2023) for more information). An overview of the intervention can be found in Figure 2.

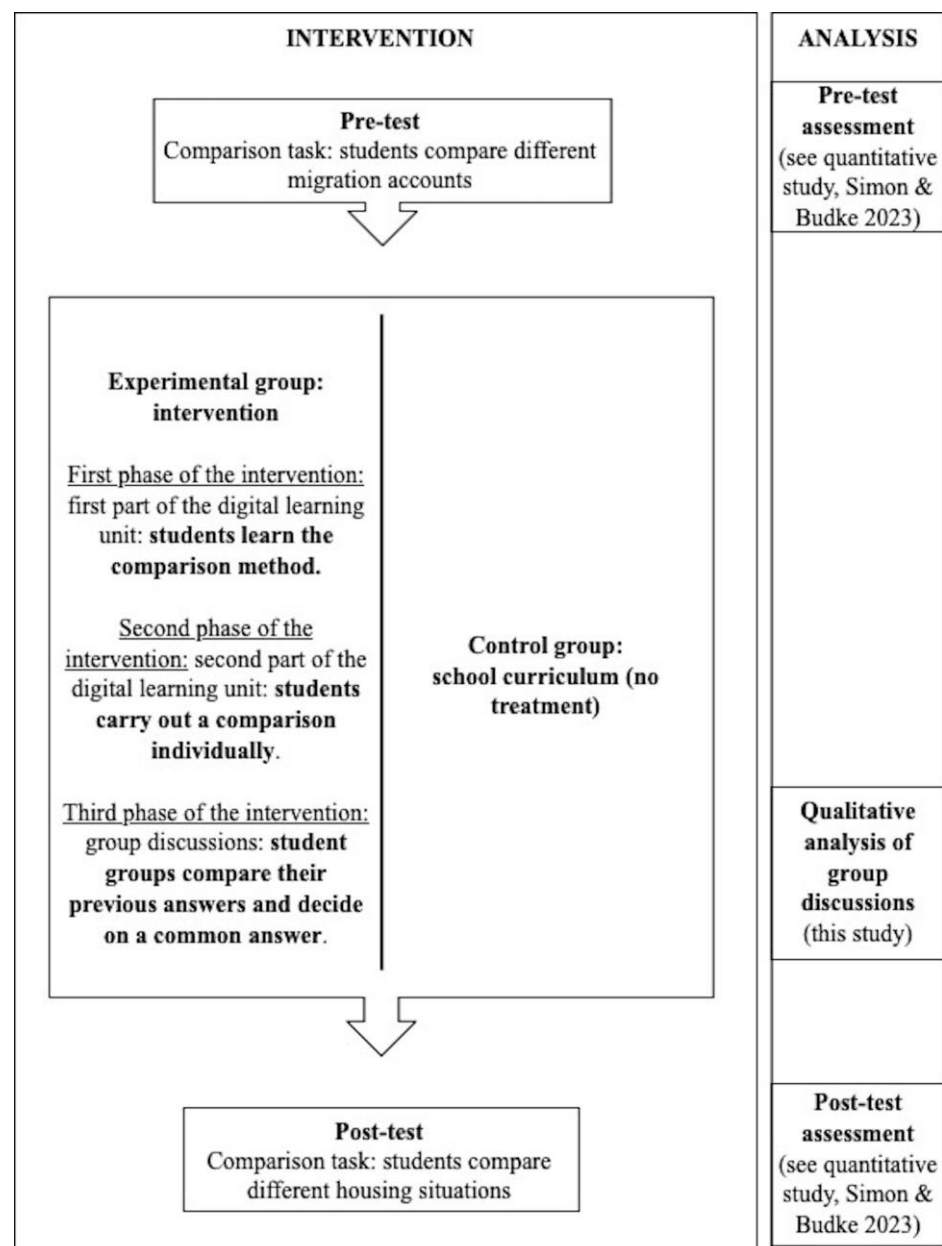
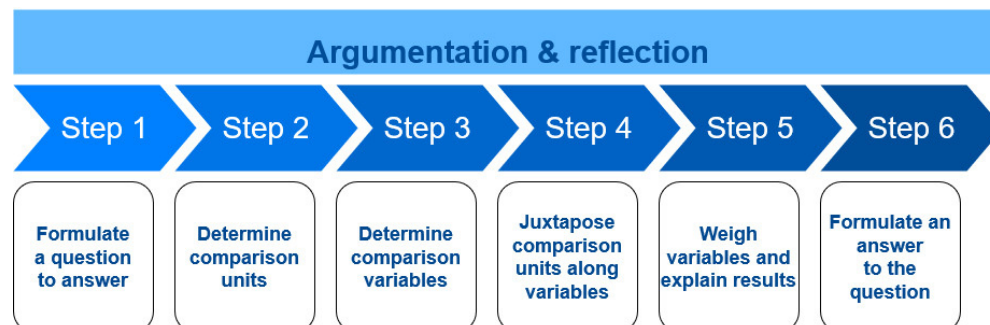


Figure 2. Overview of the intervention study and different analyses [14]. Own elaboration.

In the first phase of the intervention, students learned the comparison elements (variables, units) and the different comparison steps as described by Wilcke and Budke [23], and were adapted as a teaching tool for the intervention (see Figure 3).



**Figure 3.** Comparison steps as provided to students during the intervention. Translated from German. Own elaboration on the basis of Wilcke and Budke [23].

In the second phase of the intervention, students had to carry out a comparison. To complete the task, students were guided through the steps of the comparison method used as a scaffold: the main subject was migration, and the main question of the digital learning unit was how similar or different migrations are in time. Students were given comparison elements such as comparison units (recent human migration compared to migration from Homo sapiens). However, they decided, autonomously, which specific question or variables they wanted to investigate, which was different from usual comparison tasks found in textbooks in both countries [24,25]. For example, students could choose between investigating the reasons for migration or routes taken by migrants, and had many different data available that they could choose from to answer their question.

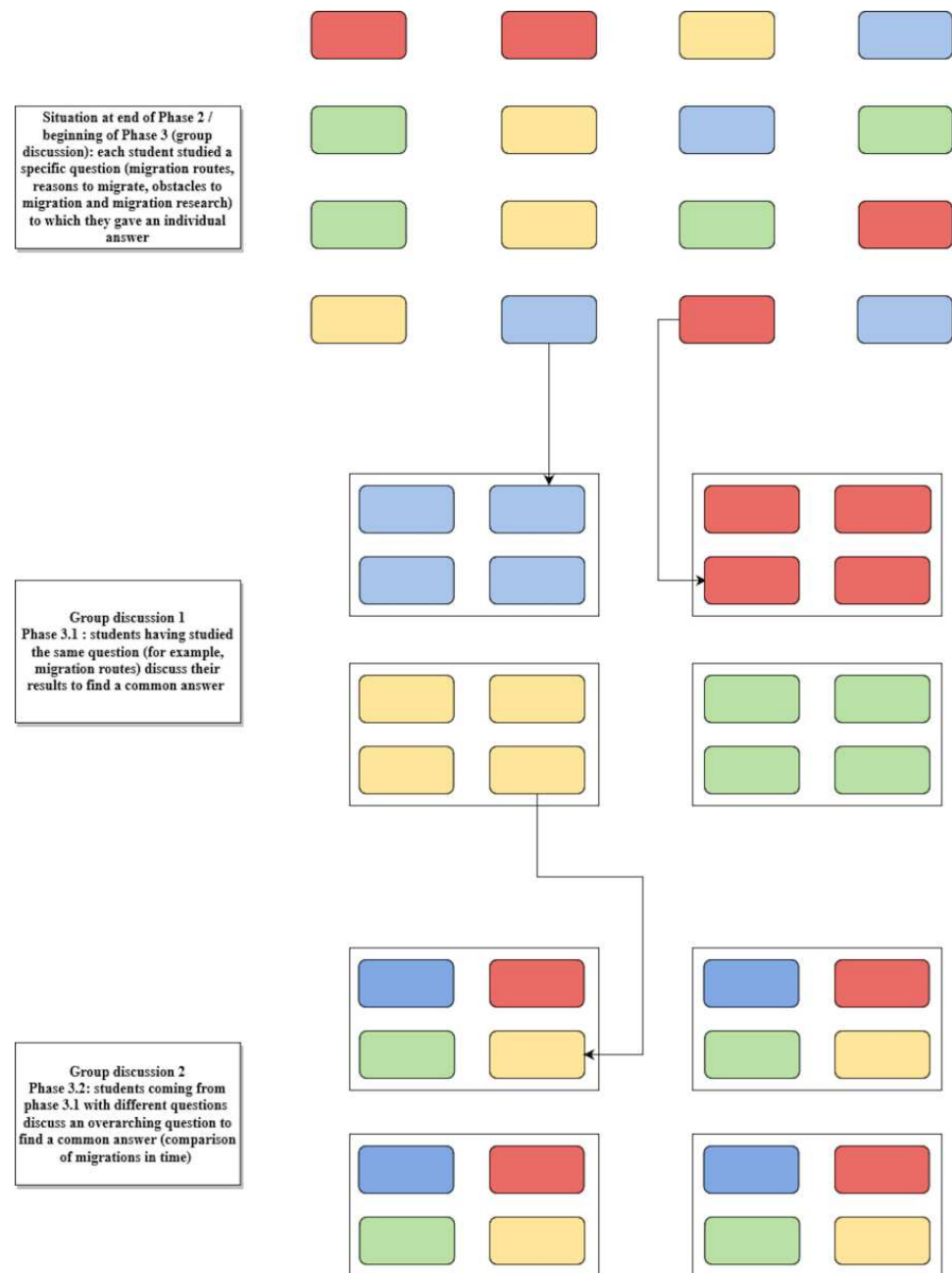
### 3.2. Description of the Third Phase: Group Discussions (Focus of This Study)

The third phase of the intervention, which is the core of this present qualitative study, was taught in a 45 min class and involved two phases of group discussions. Figure 4 provides an overview of the educational method used during the class.

Since students had worked previously on different questions around migration but had analysed different variables or data such as a video or a map, at the start of class they could have slightly different answers to the question they had chosen to study (end of phase 2, see Figure 4). Therefore, in phase 3.1 (see Figure 4) they were sorted into different groups, question by question, and had the task to compare their answers and then come to a common answer while reflecting on their previous comparison choices from phase 2. In phase 3.2 (see Figure 4), having come to a common answer, students were grouped with different students having worked on different questions. They had to answer the overall question "Are migration movements in the past and today similar or different?" To do this, they had to contrast and compare their previous answers and to defend their conclusions to come up with a common answer (Figure 5 provides an example of a task sheet from phase 3.2).

At the end of the discussion, groups were asked to produce a poster summarizing their results (see Figure 5). They were allotted 15 min to solve each task in both phases. Tasks were formulated very openly and did not provide guidance on the method to come to an answer, which allowed us to analyse groups' strategies and intents to solve the task. Both included reflection on comparison in two ways: first, because during phase 3.1 students had to reflect on the comparison of migration processes, and second, because during both phases they had to compare their own answers to come to a result. Researchers and classroom teachers were at the students' disposal but only joined the groups when students asked for help or signalled that they had completed the task. All discussions were audio-recorded and anonymised. Posters realized by the groups during phase 3.1 were

also collected. Students, parents and school staff were all informed of the research methods and objectives of our study to which all consented.



**Figure 4.** Organisation of the group discussions. Colours stand for different questions. Own elaboration.

### 3.3. Data Analysis

A total of 12 groups (4 in Germany, 8 in France) participated in each phase of the discussions. However, in each phase (3.1 and 3.2), two groups of French students decided not to deliver a recording and two other groups delivered only very short recordings of their results without delivering the discussion leading to it. None of the French groups delivered a poster, although students wrote on their task sheets.

TASK SHEET: Group discussion 2	
<b>1</b>	<p><b>Present the results</b> from the first group discussion:</p> <ul style="list-style-type: none"> <li>- <b>Present the question and the common results</b> / common answer of the group.</li> <li>- <b>Precise the conditions</b> under which these results are valid.</li> </ul>
<p><b>2</b></p> <p><b>Debate</b> in the group to find a <b>common answer</b> to the overarching question:</p> <p><b>"Are migration movements in the past and today similar or different?"</b></p> <p><b>Steps:</b></p> <p><b>a</b> <b>Choose a statement:</b> "Migration movements in the past and today are similar / different". Or: <b>formulate a different statement</b> that answers the question.</p> <p><b>b</b> <b>Build arguments to support your statement (= your assertion).</b></p> <p><i>Following formulations can help you to do this:</i></p> <ul style="list-style-type: none"> <li>- "This result becomes clear if you consider the following question(s): "</li> <li>- "This question/topic (reasons/obstacles/routes/research/....) appear to be the most important one(s), because...."</li> <li>- "Under this/these question(s), we can then conclude that migration movements are similar/different because...."</li> <li>- "Here, the following variable(s) (.....) seem to be the most important, because....."</li> <li>- "Other variables (.....) appear to be less important, because...."</li> <li>- "To support our claim, we consider following materials to be most important: ....., since....."</li> </ul> <p style="text-align: center;"><b><u>All your answers must be justified and argued.</u></b></p>	
<b>3</b>	<p><b>Prepare a poster</b> with your key statements presenting the claim and arguments.</p>

**Figure 5.** Task sheet for phase 3.2 (group discussion 2). Translated from German by the authors.

Obtained discussions were transcribed using MAXQDA and then analysed qualitatively. Our qualitative analysis was carried out in two stages: firstly, an analysis of the orientations and strategies based on the documentary method, and secondly, an analysis of groups' implementation of the comparison method. In a first qualitative analysis, we used the documentary method [47] to better understand groups' action-guiding orientations, strategies and competency acquisition during the discussions. The documentary method is used in social science to study group discussions or interviews [48], but also in education research [49]. This method allows to reconstruct the groups' implicit collective knowledge and action-guiding orientations [32,33]. First, it involves analysing the content and meaning of what is said or achieved during the group discussion. This stage is known as formulating interpretation, and enables the thematic structure of the document to be identified. The second stage of the documentary method is called reflecting interpretation. This examines how the content is formulated and discussed within the group, and thus analyses the organisation of the discourse and the interaction. It reveals the orientations guiding the actions of the members of the group, but also the extent to which the members share these collective orientations. The first author analysed all discussions, reconstructing central action-guiding orientations and deriving similarities and differences between groups' strategies. Strategies used to compare the group members' answers were also analysed in relation to the comparison method learnt during the previous phases of the

intervention to check for the integration of this method [46]. After a first validation with the second author, several researchers speaking German and/or French were asked to validate the interpretations in three sessions. During these sessions, researchers analysed the same examples of group discussions, which allowed to refine and validate the analysis.

The thematic structure of the group discussions was very much constrained by the comparison task that the students had to solve. To relate groups' used comparison strategies to individual achievements of the groups' members at the end of the intervention, we analysed, more specifically, student discussions from phase 3.1 in a second step of the analysis. Discussions were coded deductively using content analysis [50] to check the use of the comparison method steps (see Figure 3) as a strategy to solve the task, since it was also explicitly formulated in the task sheet. To conduct this, we used the same assessment of comparison steps that was used in the quantitative study (see Table 1, [14]), and allowed us to obtain a maximum of 10 points. Then, this was analysed quantitatively to see the distributions of the groups' results and their assimilation of the comparison method. The difference between German and French groups was tested for significance using a *t*-test.

**Table 1.** Assessment tool to evaluate elements of group discussions corresponding to comparison steps (based on Figure 3). Own elaboration.

Comparison Steps and Tasks	Possible Points
Step 1: formulate a question	0 or 1
Step 2: determine comparison units	0 or 1
Step 3: determine comparison variables and material used	0 or 1
Step 4: juxtapose comparison units according to comparison variables	0 or 1
Step 5: weigh comparison variables and explain results	0 or 1
Step 6: formulate an answer to the question	0 or 1
Transversal task: justify and argue on each step of the comparison process (choice of units, variables, material and justification of results)	0–4

Spearman's  $\rho$  was calculated to analyse how being in a group who used the comparison method during phase 3.1 of the discussion could correlate to students' individual improvement between the pre- and post-tests assessing comparison competency. To conduct this, we used results from the pre- and post-test from the quantitative phase of the project. These tests allowed us to assess, with an open comparison task, students' comparison competency using our already validated assessment tool (see [14,26], Table 2).

**Table 2.** Assessment tool for comparison competency assessment: list of categories to measure comparison competency [26] (p. 5). Own elaboration.

Categories to Measure Comparison Competency	Possible Points
Elements of a comparison (units and variables) are set in relation to each other in order to carry out a comparison	0 or 1
The question is implicitly or explicitly chosen	0 or 1 (implicitly) or 2 (explicitly)
Variables are implicitly or explicitly chosen	0 or 1 (implicitly) or 2 (explicitly)
Units are implicitly or explicitly chosen	0 or 1 (implicitly) or 2 (explicitly)
Material is implicitly or explicitly chosen	0 or 1 (implicitly) or 2 (explicitly)
The result of the comparison is justified argumentatively	0 or 1
The argumentative justification for the results of the comparison is successful	0 or 1
The chosen question is justified argumentatively	0 or 1
The argumentative justification for the choice of the question is successful	0 or 1
Chosen units are justified argumentatively	0 or 1
The argumentative justification for the choice of the units is successful	0 or 1
Chosen variables are justified argumentatively	0 or 1
The argumentative justification for the choice of the variables is successful	0 or 1

Table 2. Cont.

Categories to Measure Comparison Competency	Possible Points
Chosen material is justified argumentatively	0 or 1
The argumentative justification for the choice of the material is successful	0 or 1
A result of the comparison is provided	0 or 1
Comparison is made with more than 1 variable	0 or 1
Comparison is made with more than 2 units	0 or 1
Variables are weighted	0 or 1
Underlying geographical concepts are reflected with the weighting of variables	0 or 1
Comparison is used to juxtapose or rank units along the variables	0 or 1
Comparison is used to test a rule/model or show change	0 or 2
Comparison is used to question a rule/model or define a process	0 or 3
Comparison is used to formulate a rule/model or highlight the particularity of examples	0 or 4
TOTAL	Max. 28 points

Groups' comparative strategies during phase 3.2 of group discussions were reconstructed using the documentary method. To complete the analysis, Fisher's exact test was calculated to determine if there was a significant association between the use of a specific strategy to come to a result within the groups and students' individual progress between the post- and the pre-test of the intervention.

#### 4. Results

##### 4.1. Analysis of Group Interactions: Reconstruction of Groups' Action-Guiding Orientations and Strategies

In a first qualitative analysis, using the documentary method, we reconstructed the groups' collective orientations while solving the comparison tasks in phases 3.1 and 3.2 to analyse how groups dealt with an open comparison task, and which strategies they used. For clarity, results are presented using selected examples from our corpus, beginning with common action-guiding orientations and then analysing strategies to solve the task.

All groups who delivered a recording shared an orientation towards task completion. This was materialized by the fact that groups organized their work, often implicitly, with one student or two leading the group work while reading the task on the task sheet and distributing talk turns at the beginning of the task. Additionally, leading students often controlled the recording of the discussion and repeated or re-read task formulations on the task sheet.

The task completion orientation was challenged by the openness of the task. In all groups, students had difficulties dealing with this openness, which revealed an orientation towards knowledge reproduction while thinking that tasks can only have one "right" or "correct" answer. Box 1 shows a sequence from a French group in phase 3.1, and allows us to see these two main orientations reconstructed.

**Box 1.** Excerpt from a French group discussion (phase 3.1). All names are fictitious. Translated from French by the authors

"John: So now we have to get to question 3. "A common result to the question"... [0:05:17.1]  
**Charlotte:** Do we have to record this too?  
**John:** Yes. So our answers were different to the question. . .  
**Charlotte:** Yes.  
**John:** We have to come to an agreement and come up with a common answer. [0:05:40.4]  
**Charlotte:** Well we agreed that there were differences and similarities between past and present migrations. [0:05:46.1]  
**John:** Yeah. So does it have to be a nuanced answer or does it have to be a "yes" or "no" answer? [0:05:53.8]  
**Charlotte:** Erm... well if we rephrase question we can show that it's nuanced...  
**John:** Yeah, I don't know.... [0:05:59.9]"

The group in Box 1 is led by John who refers to the task sheet in a new proposition and reads elements of the task. John also controls the recording of the discussion. He is also the one repeating words such as “we have to” or “does it have”, which shows his concern to complete the task. But one can also see how unsure he is of how the task shall be answered. The form of the answer (if it is a nuanced or an exclusive answer) is very important to him, so that it is the expected one or the “right” one. This uncertainty is also visible in the pauses in speech during the recording. All groups in both countries expressed this uncertainty. Depending on the groups, some were expressing uncertainty towards the task formulations, towards the method of use to solve the task, or uncertainty towards one or the group’s own answers after formulating a result.

To overcome this uncertainty, groups developed strategies. Some were strategies to evict the task and/or the debate around the common answer. Such strategies were, for example, to realize the task as quick as possible, to state that they agreed even if they did not or to provide an answer which validity did not seem important while completing the task as quick as possible. While some students did not intervene in the discussions (as in our former example), other groups simulated debate without really debating and accepted one student’s answer as the group’s without discussing. These group strategies were visible in both countries and are shown in Box 2 with an example from phase 3.2.

**Box 2.** Excerpt from a French group discussion (phase 3.2). All names are fictitious. Translated from French by the authors

**Aude:** We have to debate ... (reads) So, in your opinion: “Is migration in the past and today similar or different?” [0:01:42.2]  
**Etienne:** For me it is rather different. For me it is rather different because new factors come into play that didn't happen before. For example, war or even political reasons mean that migration is taking place all over the world. [0:02:01.4]  
**Hélène:** For me it is also different, due to climate change, certain migratory routes have been removed or (laughter) annexed because it was either too hot or too cold so it was no longer possible. The political context, because some migration routes may have been possible before, but for example because of civil wars or... for example through Israel it's impossible to migrate. And also technological progress because now the means of transport are much more developed than those of Homo sapiens so it's different. [0:02:46.5]  
**Caroline:** Well, for me migration in the past and today is different because the climatic risks have changed, the types of transport used have changed, before they used boats that weren't very well built and now they use more modern boats and there are different types of risks linked to migration because now, because of the borders, migrants can't get back into the country like they used to at the time of Homo sapiens. [0:03:19.5]  
**Aude:** So for our group, migration in the past and today is similar because it's always for the same reasons that people migrate but it's rather that the way of migrating is different. So I think our claim will be that migration is different in the end. And erm... well, so we've given our arguments...  
**Caroline:** Well, yes, we've already set out our arguments with erm... let's stop now. [0:03:31.5]”

In this excerpt from a French group (see Box 2), debate is only simulated since all students present the conclusions from phase 3.1 without really debating on the common result. Each student says “for me” at the beginning of their answer but does not try to convince others why their results shall weigh in the common answer. The interaction can be synthesized in a succession of propositions without relation within them, although the whole discussion is supposed to be a debate. In the end, the leading student (Aude) formulates a common answer rather rapidly (“migration is different”). She abides by others’ conclusions, although her own group had said the contrary. Here, we can clearly see a common strategy to solve the task as quickly as possible and to formulate an answer, in which validity is not a concern, while simulating a debate. Again, these strategies highlight the common orientations, which were task completion and the culture of the “right answer” while trying to find a solution to the task.

Other strategies aimed to seek security or help while solving the task. Different means were recurred to, such as using the task sheet and following instructions, asking teachers or researchers for help, trying to look at what other groups answered, writing their ideas or

realizing the poster to structure their ideas. An excerpt from a German discussion in phase 3.2 can serve as an example (see Box 3).

**Box 3.** Excerpt from a German group discussion (phase 3.2). All names are fictitious. Translated from German by the authors

**Nina:** “Prepare a poster with your key messages”. Yes, I think we could write reasons colon, obstacles colon, route colon and conclusion and see if that has changed or not. [0:05:26.1]  
**Lars:** Normally I would look somewhere for inspiration, but I don’t think it would be a good idea if I got up now.  
**Anne:** The thing is, I thought we were going to say that altogether now.  
**Nina:** Shall I ask?  
**Anne:** Yeah, I would say.  
**Nina:** You ask best. [0:06:07.0]  
**Anne (to researcher):** Are we supposed to say that altogether or is the idea now that everyone from a group writes down, so to speak, reasons, obstacles, routes and then we write down “it is similar because of that”, “it is different because of that”? Or should we really do that altogether? [0:06:20.2]”

In this discussion (see Box 3), the group, led by Nina, discusses in a very short time different strategies to solve the task. While Nina discusses how the poster shall be structured, Lars does mention the possibility to look at another group’s answers. They also ask the researcher to detail the task formulation. These strategies were used diversely by all groups, although French students did not deliver posters presenting their ideas but wrote their answers on their task sheets (designing a poster to write down ideas is not a very common task in older classes).

Finally, groups did use different strategies to formulate an answer to the common question as it was the task in phase 3.2. All of them started with listing all answers. Then, to come to an answer, three specific strategies could be reconstructed within the groups. Among the ten groups, five (two from France, three from Germany) formulated an answer based on the majority of responses. For example, if three previous groups had said “migration in the past and recent migration are similar”, then it would also be the group’s answer, although one student would disagree. By contrast, two groups (one in each country) used the weighting of variables to come to an answer and thus used a strategy learned during the intervention to solve the task. One French group only listed answers and did not use a specific strategy, refusing to take position (their answer was thus: “migration is similar and different”). The last two groups only delivered a short recording, not allowing identification a specific strategy. Box 2 shows how a French group recurred to the majority strategy to come to an answer, whereas Box 4 shows how a group came to weigh variables.

This conversation shows how, in this group, students discuss the fact that the answer is not a simple answer. This possible distancing from the orientation, to think that the task only meant to provide a specific “correct” answer, leads in the following: first, list all the answers like all groups did, but in a second phase, to provide a real weighting of variables. This is visible in the dialog between students after Juliette says “I think it’s different”, with students discussing variables (such as factors, geographical scale, routes, modes of transportation) and then Juliette reformulating the claim “migration in the past and today is different” after having stated that “ways are more important”. Here, the whole interaction shows how a specific student (Juliette) leads the organisation of speech, but also reflection. When Juliette reflects on the task, there are some hesitations, which still show signs of uncertainty towards the group’s results. However, the answer is clearly formulated in the end, and Juliette asks the rest of the group to validate her result. In this short excerpt, we can notice the use of the comparison method to solve the task, since the weighting of variables was explained during the whole intervention as a way to evaluate the results and to nuance them. Thus, a specific moment of comparison competency manifestation is recorded here. However, one specific student (Juliette) dominates the whole discussion and comparison competency acquisition for the whole group is not confirmed by this excerpt.



**Box 4.** Excerpt from a French group discussion (phase 3.2). All names are fictitious. Translated from French by the authors

**Juliette:** The issue is whether migration in the past and today is similar or different. So if we summarise groups 1, 2 and 3. . .

**Arthur:** Well, there are differences and similarities on different scales.

**Juliette:** I don't think the answer is necessarily closed. There are necessarily several possibilities and several answers. The answers are not simple. So, group 1 had rather similarities. [0:05:54.2]

**Paul:** In the similarities we had climatic and political factors, so. . . in terms of wars. [0:06:01.0]

**Juliette:** Group 2...

**Pierre:** Transportation...

**Arthur:** Different modes of transport.

**Pierre:** and new ways of preventing migrants from crossing, for example border control. [0:06:33.6]

**Juliette:** And then in the differences there have been major climatic changes which have meant that migratory routes have diversified and/or have simply been replaced. There have also been political changes which have meant that certain routes have been blocked or have become more difficult to cross. Globalisation has meant that routes have diversified on a global scale rather than on a continental scale, and technological changes have meant that people can move more or less easily over longer or shorter distances. (10 seconds pause).

So... the tendency is... well, personally I think it's different. If we were to... it's not the same scale at all, it's not the same modes of transportation at all...

**Pierre:** It's not the same era.

**Juliette:** Yes, there are a lot of things that make it different after all... [0:07:18.2]

**Paul:** It's the same factors but there are factors that are different too...

**Pierre:** It's the same... war and all that, it's always existed.

**Juliette:** But the ways are totally different.

**Pierre:** And the means are different. [0:07:26.4]

**Juliette:** Since we're thinking the ways are more important, I think it's important to underline that, personally, I would choose, and I think you agree that we would choose the claim "migration in the past and today is different". So can we agree on that now?

**All:** Yes. [0:07:43.8]

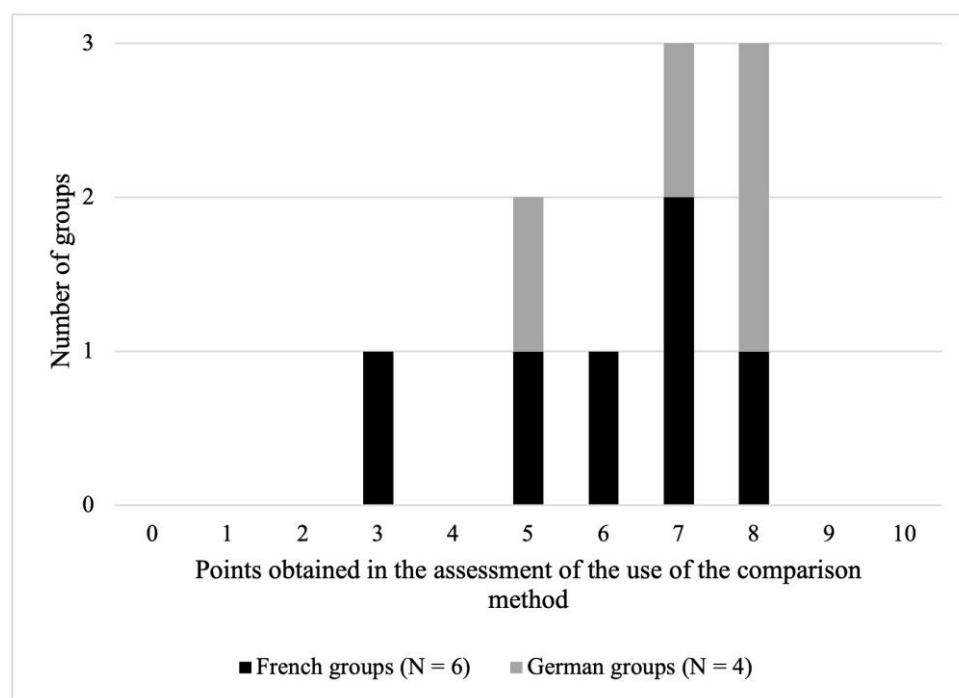
**Juliette:** So the arguments to support our claim... Well, as we've said, for political, climatic and technological reasons, globalisation has changed the ways and means of creating migratory routes. As Pierre said, customs also make migratory movements more or less difficult or easy in some cases. We could also say, however, that there are similarities that suggest that migration routes are not totally different from those of the past." [0:08:33.2]

#### 4.2. Analysis of the Use of the Comparison Method as a Strategy in the Group Discussions

In a second phase, group discussions in phase 3.1 were evaluated via deductive content analysis [50] to analyse the use of the comparison method in their answers on migration processes, as task completion orientation based their answers and as the task sheets structured the thematic organization of the discussions (see Table 1). Results are presented in Figure 6, which show, cumulatively and by identifying the groups according to the country, the number of points obtained in our assessment of the use of the comparison method (for example, three groups in total (one German and two French groups) obtained seven points in the assessment).

Groups obtained results between 3 and 8 points out of a maximum of 10 points, with a mean of 6.4 points and a median of 7. These results show that students used the comparison method as they were asked by the task sheet. Only one group obtained less than half of the possible points (10). German groups performed slightly better than French groups, obtaining a mean of 7 and a median of 7.5, while French groups obtained a mean of 6 and a median of 6.5. However, there was no statistically significant difference between results in the two groups as the *t*-test showed,  $t(8) = -0.934$ ,  $p = 0.378$ . All groups formulated their research question and answered it (Steps 1 and 6, see Figure 3 and Table 1) with juxtaposed comparison units according to comparison variables (Step 4, see Figure 3 and Table 1). However, only 50% of German (two out of four) and French groups (three out of six) could identify properly the comparison units, and only three German groups (75%) and four French groups (66.6%) could identify comparison variables and the data used to compare (Steps 2 and 3, see Figure 3 and Table 1). All groups did explain their results, but one French

group did not weigh the variables (Step 5, see Figure 3 and Table 1). This group was also the only one not arguing on the steps of the comparison process, since the recording mainly consisted of the results of the comparison. However, although groups argued about the obtained results points (Transversal task, see Figure 3 and Table 1), they did not argue to justify the choice of comparison elements with five groups (1 German, 4 French), obtaining only 1 point out of 4 possible points in this task and four groups (3 German, 1 French) only obtaining two points.



**Figure 6.** Group distribution of points obtained in the assessment of the use of the comparison method. Own elaboration.

We correlated groups' performances in this assessment to students' individual progress between results in the pre- and the post-test during the intervention. Overall, students from the experimental group had obtained better results in the post-test (mean of 12.68 points out of possible 28 points in the test) than in the pre-test (mean of 10.05 points), with a significant net difference of 2.64 points. Progress was made in all dimensions of comparison competency (see [14] for more detail). Being in a group who used the comparison method extensively during phase 3.1 of the intervention (first part of the group discussions phase), correlated rather strongly [51] to individual students' improvement between the pre- and the post-test: Spearman's  $\rho = 0.412$ ,  $p = 0.009$ . This indicates a positive relationship between the use of the comparison method, which was learnt, practised in each phase of the intervention, and also presents as a scaffold in the task sheets for the group phase, and the development of comparison competency.

#### 4.3. Correlation of Groups' Strategies to Students' Individual Achievements during the Intervention

Our qualitative analysis following the documentary method showed that groups of students selected different strategies to come to an answer to the question "are migration movements today and in the past similar or different?": either they formulated an answer after the majority of responses, or they weighted variables, or did not follow a specific strategy, or did not deliver a recording. These strategies allowed them to provide four sorts of answers: either a nuanced answer, an exclusive answer, an undecided answer, or no answer (see Table 3).

**Table 3.** Distribution of strategies and types of answers to solve the comparison task. N = 12 (Two French groups did not deliver a recording). Own elaboration.

Types of Strategies to Come to an Answer	Types of Answers to the Overall Comparison Task			
	Nuanced Answer (for Example: “Recent and Past Migration Is Rather Different But Some Elements Are Still Similar”)	Exclusive Answer (for Example: “Recent and Past Migration Is Similar”)	Undecided Answer (for Example: “Recent and Past Migration Is Similar and Different”)	No Answer
Strategy: majority of responses	3 German groups	2 French groups	-	-
Strategy: weighting of variables	1 French group, 1 German group	-	-	-
No specific strategy	-	-	1 French group	1 French group
No recording of the strategy	1 French group	-	-	-

The four German groups all formulated a nuanced answer as did two French groups (see Table 3). Two French groups delivered an exclusive answer, and another French group formulated an undecided answer (see Table 3). One French group did not deliver an answer. We calculated the relation between being in a group using a specific strategy and individuals’ achievements in post-test using Fisher’s exact test. Results are presented in Table 4.

**Table 4.** Cross table of students’ individual improvement in comparison competency between post- and pre-test, related to the use of specific strategies to solve the comparison task in phase 3.2 of the group discussion. Own elaboration.

Individual Improvement of Students’ Comparison Competency between The Pre- and Post-Test	Strategies during the Group Discussion				Total
	Answer Based on The Majority of Responses	Answer Based on The Weighting of Variables	Answer Based on no Specific Strategy	no Recording Delivered or no Recording of the Strategy	
Individual improvement in comparison competency between the pre- and the post-test	2	4	0	8	14
No individual improvement in comparison competency between the pre- and the post-test	17	4	5	4	30
Total of students	19	8	5	12	44

An improvement between pre- and post-test and strategy of the pupils was significantly correlated ( $p = 0.002$ ). Students performed better in the post-test when they had completed the task entirely during the group discussions and come up to an answer, than students not completing the task (see Table 4). These first elements show that solving the task during group discussions correlated to individual comparison competency acquisition. However, although the strategy of weighting variables had been learned during the intervention, its use during group discussions was not the strategy that better correlated to improvement between the post- and the pre-test. On average, more students progressed who were in groups that based their answer on the majority of responses and in the group not having chosen a specific strategy, than students being in groups who used the weighting of variables (see Table 4).

## 5. Discussion

In this article, we presented results from a qualitative analysis of group discussions that took place during an intervention study, in which students implemented the comparison method, with 44 French and German students from our experimental group. Our objective was to analyse students' action-guiding orientations and strategies while exploring how groups solved open comparison tasks, in order to relate strategies to individual comparison skill improvement and to identify possible differences between German and French students. This study provides first insights on comparison competency acquisition processes, responding to calls for research in the area of skill development [27]. Our analysis of groups' strategies and action-guiding orientations while solving open comparison tasks also provides insights into possible explanations for our quantitative analysis, which showed students' competency improvement during the intervention [14].

German and French groups shared a similar orientation towards task completion, which could be reconstructed via the use of the documentary method [47,48]. This general action-guiding orientation, visible in all group recordings, is common, since it corresponds to the "student job" [35,36] and was also reconstructed in other research situations [34]. This also corresponds to students "doing the lesson" as analysed by Jiménez-Aleixandre et al. [37]. Martens and Asbrand [34] (p. 64) have described in their typology, within the task completion orientation, how a frequent type of action is to deliver a result (such as a poster or a completed task sheet). While delivering this result, students try to be efficient, do not necessarily identify with the result or with the subject matter and do not analyse it deeply. In our study, this orientation and corresponding strategies (such as answering as quick as possible) could also be reconstructed. A second action-guiding orientation was visible in our corpus, in which students from both countries tried to look for the "right" or the "correct" answer. Students did express their uncertainty towards the way to solve the task and their own answers, and showed uneasiness towards the task's openness. This is consistent with other research results which showed how students tried to tell a "story of success" while solving the task, instead of reflecting on inquiry hesitations or processes [52], and which described this type of action within the task completion orientation as knowledge reproduction [34]. Luhmann [9] and Perrenoud [36] also showed how students are used to closed tasks whose answers are often already known by the teacher. This result shows that using open tasks can be a challenge in interventions and, more generally, in geography education since students in Germany and France are not used to this approach as our textbook analysis showed [24,25]. Perrenoud [53] described how the changing culture towards competency acquisition can meet resistance from students who have to accept the change in the "didactic contract". This resistance from students in our study was also shown in students' uneasiness towards the research situation. Some groups did either not deliver a recording, or delivered very short recordings (this was the case in the French group with two groups in each phase). Also, some students did not participate with the group discussions, leaving for other members of the group to take decisions and discuss tasks. Even in some of the groups who did deliver recordings and answered the task, laughing attitudes, off topic conversations and attitudes of refusal were observed, although this was less of the case in phase 3.2 than in phase 3.1, revealing a possible adaption to the research situation. In the French group, uneasiness towards the group work was also visible, with some groups experiencing difficulties to work collaboratively and no group delivering a poster, which was actually the task. This shows that comparison competency acquisition via group discussion and, more generally, competency acquisition through open tasks in a scientific context should be implemented in schools in the long term. Although our intervention allowed to show the potentiality of such an approach, real competency acquisition would indeed need the construction of a new long term habitus [34,54]. It would allow, within the task completion, orientation to make a shift from the "delivery of a result" and "knowledge reproduction" task completion orientation types, towards the "own construction of [geographical] knowledge and processes" type [34], and to take a step back from the "normative nature of classroom discourse" [4] (p. 5). It would also

narrow the gap between school and academic culture [10,11] and enhance the development in schools of geographical thinking [12,19].

Strategies to overcome uncertainty towards an open task were developed by student groups from both countries. Some were strategies of task eviction or “job” eviction, also identified in other works [36] (pp. 15–16) such as cheating, trying to be forgotten (in our study, students who did not intervene) or simulating task solving. For example, our group discussions showed eviction and simulation of argumentative debate, with students often accepting one (often the leading) student’s idea as the group’s solution (see Boxes 2 and 4), as was also shown in other works [45] (p. 83). Other strategies could be reconstructed, which related to solving the comparison task in an effective manner. A first strategy was to use the comparison method to discuss the subject matter, as expected in the task sheet in phase 3.1, confirming the task completion orientation by applying the comparison method. The use of our assessment tool allowed to analyse this strategy more deeply. German students performed slightly better than French students, though we found no statistically significant difference as results of the t-test showed. Our assessment allowed us to notice that groups rarely used argumentation to justify their choices in the comparison process, confirming our results from former studies in which we showed that students had difficulties in this dimension of comparison competency [14,26]. Other studies also showed that students’ skills concerning argumentation are rather low [55] (p. 68), [56] (p. 59). However, students who were in groups who used the comparison method also performed better in the intervention’s post-test than students who were in groups that did not use it to solve this task. This result is in accordance with our previous results from our quantitative study, where we could positively correlate the use of the comparison method during the individual learning phase to individual achievements during the intervention. This confirms, first, the necessity to reinforce argumentation skills to support students in the acquisition of geographical competencies such as comparison and, second, that the comparison method used as a scaffold contributes to enhance comparison competency [14].

Some of the groups solved the comparison task in phase 3.2 while adopting different strategies to come to different types of answers. This could be positively correlated to individual improvements in comparison competency between the pre- and the post-test, allowing us to state that group discussions on open tasks can contribute to competency acquisition. Answers and strategies which did not relate to the comparison method (such as the majority strategy or not deciding on a specific strategy) were used by students who also performed better in the post-test during the intervention. This was also the case in the study from Knight et al. [39], in which even false answers within the groups contributed to positive learning outcomes. Our reconstruction of strategies allowed to see how comparison competency was also trained in a few groups (see Box 4) while solving the comparison task in phase 3.2, in which students had to compare their answers. Although the strategy of weighting variables was only observed in two groups (one French, one German), and its use was hesitant and often led by one student (see Box 4), students chose freely to use it to solve the task, and its use can indicate a moment of collaborative competency acquisition through discussion. Finally, German and French students showed similar uncertainty towards the open comparison task, adopted rather similar strategies and patterns of action in group discussions. Differences between the groups’ use of the comparison method were not significant. German groups formulated nuanced answers when French groups formulated different types of answers (exclusive, nuanced, undecided). Since there was a difference in the number of French students, compared to the number of German students in our intervention, this result would need replication and further research.

## 6. Conclusions

Enhancing scientific literacy in schools is a challenge if educational actors and students doing their “student job” are still very much influenced by a closed-task culture. In our study, we used an open task in group discussions with French and German students to train comparison competency after students had learned the comparison method in the

first part of the intervention. Our analysis allowed to combine qualitative and quantitative approaches in a mixed-method design. We found that group discussions contributed to individual comparison competency acquisition, but that students had difficulties with the openness of the task. Using the comparison method as a scaffold provided with the task helped students with structuring their answers and developing strategies. However, consolidating competency acquisition seems necessary in the long term. Competency acquisition to enhance scientific and geographical literacy should be reflected in classrooms as a new task culture, which would allow errors and reflection around the scientific process.

**Author Contributions:** Conceptualization, M.S. and A.B.; Investigation, M.S.; Data curation, M.S.; Writing – original draft, M.S.; Writing – review & editing, M.S. and A.B.; Visualization, M.S.; Supervision, A.B.; Project administration, A.B.; Funding acquisition, A.B. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research was funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation)–Project Number 57444011–SFB 806. The digital learning unit (OER) was funded by the Bundesministerium für Bildung und Forschung (BMBF, Federal Ministry of Education and Research) in the DiGeo project under the funding code 16DHB3003.

**Institutional Review Board Statement:** The study was conducted in accordance with the Declaration of Helsinki, but did not require approval of an ethics committee as data collection did not pose any threats and did not imply physical or psychological stress for the respondents, as the German Research Foundation (DFG) states.

**Informed Consent Statement:** Informed consent was obtained from all subjects involved in the study.

**Data Availability Statement:** Data presented in this study is available on request from the corresponding author.

**Acknowledgments:** The authors would like to thank Frank Schäbitz for his support, and the students and teachers who participated in the study for their collaboration.

**Conflicts of Interest:** The authors declare no conflict of interest.

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## **5. Summary of results**

This chapter presents the results of the five studies at the focus of this dissertation. The general research questions raised were: (1) how can we model and assess comparison competency in geography education internationally, (2) how competent are students while performing geographical comparisons and (3) to what extent can tools or scaffolds contribute to enhance comparison competency? In accordance with the objectives of this dissertation, the first Phase of the five studies was to provide theoretical approaches to comparison competency in geography education and to analyse how textbook tasks enhance comparison competency (see Figure 4). In Phase 2, an assessment tool was developed to assess comparison competency. This tool was tested on university students, while a digital learning unit was also developed and implemented to prepare for the intervention phase. In Phase 3, an intervention study was conducted to investigate whether the comparison method, when used as a teaching tool and as a scaffold, can effectively enhance students' comparison competency. Additionally, the study aimed to identify the strategies that student groups developed during the intervention. The following section presents the results of the five studies in a unified manner, while analysing the following four aspects: 1) theoretical results (5.1), 2) empirical results on the existing situation of comparison competency (5.2), 3) the possible ways and didactic tools to enhance comparison competency (5.3), and 4) the results in terms of international comparison (5.4).

### **5.1 Theoretical results on comparison competency in geography education**

The initial findings of the dissertation provide a theoretical foundation for the further development of educational and didactic support such as tasks, material or scaffolds to enhance comparison competency. The findings of Studies 1, 2 and 3 contribute to the conceptualisation of comparison competency via the typology of educational objectives which are to be achieved with comparison tasks, via the competency model for comparison competency and via the assessment tool for comparison competency (Simon et al., 2020; Simon & Budke, 2020, 2024b). The three models are mutually reinforcing: the competency model for comparison competency was based on the typology of comparison objectives, while the assessment tool for comparison was the operationalisation of the competency model in the form of criteria for competency assessment. The three studies addressed the first research question:

*“(1) How can we model and assess comparison competency in geography education internationally?”*

The typology of comparison tasks’ objectives from Study 1 (Simon et al., 2020) was constructed through an inductive and deductive process (Mayring, 2014) based on the categorisation of comparison tasks observed in textbooks. The categories that emerged corresponded, in a first instance, to the common division between lower-order and higher-order tasks (Jo & Bednarz, 2009; Krathwohl, 2002; Krause et al., 2017). The comparison objectives observed in geography textbooks were either complex or simple, as are scientific comparison objectives (Gervais-Lambony, 2000; Lijphart, 1971). This allowed for the separation of simple and complex comparison tasks. Simple tasks permit the observation or description of comparison units and variables, whereas complex tasks allow to draw further conclusions and the achievement of higher goals through comparisons. Upon further categorisation of comparison tasks, five comparison objectives emerged. In Type 1, comparisons are used to build theory or to differentiate case studies; in Type 2, they are used to apply or test models; in Type 3, comparisons have the objective to rank; in Type 4, to characterise changes or patterns; in Type 5, to train media literacy. These objectives correspond, firstly, to common scientific objectives related to comparison processes (Types 1, 2, 3, 4) (Bartolini, 1993; Lijphart, 1971; Scott & Storper, 2015; Skocpol & Somers, 1980; Weber, 1921), and, secondly, to the methodological objective of training media literacy (Type 5). The validity and reliability of this theoretical result was granted by the strong theoretical correspondence between the categorisation and scientific literature, as well as the calculation of inter- and inter-coder reliability (Landis & Koch, 1977). Furthermore, all tasks from the textbook analysis (981 tasks) were categorised, thus reinforcing the reliability of the theoretical result. Moreover, the categorisation process yielded results that corroborated previous findings regarding the potential outcomes of textbook tasks in the three countries (Budke, 2011; Colin et al., 2019; Lee & Catling, 2017).

This typology was employed as the basis for the development of the comparison competency model in Study 2 (Simon & Budke, 2020), which was also informed by Wilcke & Budke’s model for the comparison method in geography education (Wilcke & Budke, 2019). This theoretical structure-level model defines two methodological and two content-related dimensions and theorises four levels of comparison competency per dimension. The division of comparison competency into four dimensions is intended to encompass the complexity of comparison processes, which must be argued and reflected upon at each stage of the comparison process. In Dimension 1 (Planning and Implementation of Comparison Processes), the

processes of comparison are planned and implemented, with the selection of the geographical question, comparison elements and material to lead the comparison. A single dimension (Dimension 2: Reflection and Argumentative Justification of Comparison Processes) is dedicated to reflection and argumentation, which are necessitated at each step of the comparison process. The third and fourth dimensions of the comparison competency model are content-related (Dimension 3: Interrelation of Geographical Information; Dimension 4: Achievement of Comparison Objectives). Dimension 3 addresses the intricacies of comparison, incorporating additional variables pertaining to units, weighting variables, and contemplating geographical contexts and concepts. In Dimension 4, the educational objectives from Study 1, which relate to the scientific objectives of comparison, are integrated. The competency model was then tested on textbook tasks in the textbook analysis which were classified in the model's dimensions and levels. The classification was tested using inter-coder reliability (Landis & Koch, 1977). Results confirmed the common shortcomings of geography textbooks with regard to competency development (Budke, 2011; Colin et al., 2019; Lee & Catling, 2017), which allowed the model to be stated as valid.

In Study 3 (Simon & Budke, 2024b), an assessment tool was developed based on the comparison competency model to assess students' comparison competency. The assessment tool comprises two distinct components: an assessment of comparison competency and an assessment of comparison texts' structures. The assessment tool allows for the assessment of all possible levels of comparison competency and all four dimensions, building on the findings of Study 2 and the comparison competency structure model. Additionally, the assessment tool includes a section to evaluate the structures of comparison texts based on existing analyses and scales from discourse analysis and language teaching research (Englert & Hiebert, 1984; Hammann & Stevens, 2003; Spivey, 1991). The assessment tool was validated by examining face and construct validity, and found to be reliable with the calculation of inter- and intra-coder reliability (Landis & Koch, 1977). The results of the students' essays, graded using this assessment tool, were in accordance with those of Studies 1 and 2 (Simon et al., 2020; Simon & Budke, 2020) and with previous studies, which also demonstrated students' low argumentation skills (Budke et al., 2010b; Budke & Kuckuck, 2017a; Uhlenwinkel, 2015). This allowed the tool to be validated. All three theoretical constructs were implemented in subsequent studies.

## **5.2 Empirical results on textbooks' existing enhancement of comparison competency and students' existing proficiency in comparison competency in geography education**

Secondly, the dissertation presented empirical evidence to assess if textbooks' comparison tasks are suitable, first, to achieve complex comparison objectives, and, second, to foster comparison competency (Study 1, see Simon et al., 2020, and Study 2, see Simon & Budke, 2020). Additionally, it examined the comparison competency and performance of prospective geography teacher students (Study 3, see Simon & Budke, 2024b) and high school students in France and Germany (Study 4, see Simon & Budke, 2024a). All these studies provided results to answer the second general research question:

*“(2) How competent are students while performing geographical comparisons?”*

Results from Study 1 showed that textbooks include a substantial number of comparison tasks (9.18% of all tasks, see Simon et al., 2020). The number of comparison tasks increases slightly with the age of the students. Consequently, comparison is a common task for pupils. However, the results of the classification of comparison tasks in the typology of objectives of comparison tasks and in the competency model demonstrated that comparison tasks often do not facilitate the development of complex comparisons or the attainment of high levels of the competency model. Firstly, the findings indicated that the distribution of comparison tasks is quite even: a substantial number of tasks (48.85%) engage in complex comparisons, but a significant proportion of tasks are of a more elementary nature, focusing on reproduction and closed tasks (51.15%). Such closed and content-oriented comparison tasks often leave the students no autonomy and provide them with the elements of the comparison, such as comparison units, variables and materials to be use. Results from such tasks are not to be interpreted, reflected or justified. Comparison in these tasks is not seen as a useful method to acquire knowledge or which has to be reflected on. Secondly, the data revealed a notable concentration of comparison tasks within Type 1 of the objectives of comparison tasks, which pertains to inductive approaches aimed at either formulating rules based on generalisation or demonstrating the uniqueness of the examples under comparison. Other possible objectives of comparison tasks are much less used. As a consequence, 28.4% of tasks only ask students to simply juxtapose given comparison units along given comparison variables (Type 1.1: juxtaposition). Other results showed that the integration of comparison tasks into textbook pages varies according to

the objective of the comparison. Tasks' objectives frequently reflect educational functions. For instance, inductive comparisons are more frequently proposed in the pages devoted to case studies, with the aim of formulating the rules and concepts used later in the lesson in a more general way. As a consequence, Study 1's main results were the focus on inductive processes and the presence of a high proportion of closed reproductive tasks, which shows that many comparison tasks are not suitable to foster complex comparisons and do not use the possible variety of comparison objectives.

The findings of Study 2 indicated that the performance of the comparison tasks in terms of their ability to develop the competency of comparison is similarly disappointing. Only a small number of the tasks facilitate the development of methodological competencies in the selection of elements for comparison (Dimension 1: Planning and Implementation of comparison processes) and in the argumentation required to carry out comparison processes (Dimension 2: Reflection and Argumentative Justification of Comparison Processes). Only few tasks enhance autonomy in the comparison process, concentrating on knowledge acquisition. In Dimension 2, 74.1% of tasks do not require argumentation to solve the task, and argumentation is often only needed to justify obtained results without reflection or argumentation on the comparison process. In Dimension 3 (Interrelation of Geographical Information), results were similarly disappointing. Few tasks use complex comparisons including more than one variable or the weighing of variables. Conversely, more promising results were obtained in Dimension 4 (Achievement of Comparison Objectives), with 40.2% of comparison tasks reaching level 4. This confirmed the findings of Study 1 and indicated that the tasks are more focused on the acquisition of knowledge and content than on the development of methodological competencies. Results from both Studies 1 and 2 were in accordance with former results relative to the closed, reproductive and content-oriented nature of textbooks or textbook tasks (Budke, 2011; Colin et al., 2019; Graves & Murphy, 2000; Krause et al., 2017; Lee & Catling, 2017).

The use of the assessment instrument in Studies 3 and 4 assessed the competency of university geography students future geography teachers in Germany, as well as secondary school students in France and Germany. Both studies showed a relatively low level of competency among university students (10.76 out of 28 points) and high school students (10.05 out of 28 points in the experimental group and 11.51 out of 28 points in the control group). In both studies, the majority of students achieved level 3 of the first dimension of the competency model (Dimension 1: Planning and Implementation of comparison processes), largely due to the formulation of an open-ended task that allowed them to be autonomous in the choice of units, variables and the question chosen. Despite this good result, few of them explicitly chose the

elements of comparison. Both groups of students obtained low scores in the second dimension of the comparison competency (Dimension 2: Reflection and Argumentative Justification of Comparison Processes), related to reasoning about the results of the comparison and arguing on the selection of the comparison elements. Scores in the third dimension (Dimension 3: Interrelation of Geographical Information) were slightly better since students used more than one variable in their comparison. They performed also much better in the fourth dimension of the competency model relating to the objectives of comparison (Dimension 4: Achievement of Comparison Objectives), since a significant proportion (29.42% of the university students, 38.64% of the high school students in the experimental group and 48.72% of the high school students in the control group) achieved level 4 in this dimension. The results of these two studies mirror the results of Studies 1 and 2 (Simon et al., 2020; Simon & Budke, 2020) and confirm the content orientation of tasks or activities implanting comparison in secondary education, which do not enable students to develop skills in the methodological dimensions of comparison competency, as other authors also showed (Graves & Murphy, 2000; Lee & Catling, 2017). Dimension 2, which relates to supporting the comparative process through argumentation and reflection, seems to be the dimension that needs the most support from potential scaffolds, which is consistent with former findings on students' argumentative competencies which were found to be very low (Budke et al., 2010b; Budke & Kuckuck, 2017a; Uhlenwinkel, 2015). Furthermore, Study 3 showed that most students structured their comparison texts by choosing either a text structure organised unit per unit, or a text structure organised variable per variable, or a mixed structure presenting first the material and then analysing differences and similarities, and that there is a need to develop teaching tools to better develop the structuring of comparison texts.

### **5.3 Results on the development and test of pedagogical tools and scaffolds to enhance comparison competency**

In order to enhance comparison competency, pedagogical tools and scaffolds were developed and tested in accordance with the theoretical tools formulated in Studies 1, 2 and 3, as well as the diagnosis made by the same Studies 1, 2 and 3 (Simon et al., 2020; Simon & Budke, 2020, 2024b), which indicated that students have difficulties in the first three dimensions of the model for comparison competency, with the argumentative dimension being the most problematic. These studies allowed to answer the following research question:

*“(3) To what extent can tools or scaffolds contribute to enhance comparison competency?”*

Study 4 (Simon & Budke, 2024a) tested not only the online teaching unit published as an Open Educational Resource (OER<sup>4</sup>), but also the comparison method used as a scaffold. In this study, an intervention was carried out with 44 pupils in the experimental group (29 French and 15 German) while 39 pupils (31 French and 8 German) belonged to a control group. The intervention and the digital teaching unit employed a “mixed” approach (Cavagnetto, 2010, p. 11), initially instructing students in the comparison method in a direct manner, and subsequently allowing them to engage in a research situation in which they were autonomous. Results of the intervention demonstrated that students in the experimental group significantly improved their scores between the pre- and post-tests with a net difference of + 2,64 points, while students in the control group demonstrated a significant decrease in performance in the post-test, in comparison to the pre-test (net difference of -1.49 points). The study employed ANCOVA to show that the observed differences between the pre- and post-tests could be attributed, at least in part, to the intervention ( $F(1, 80) = 20.258, p < .001, \text{partial } \eta^2 = .202$ ). These results validated the structure of the intervention and the digital teaching unit as having demonstrated its effectiveness on student performance. Furthermore, the results of Study 4 showed that the utilisation of the comparison method in the second phase of the intervention, as previously learned during the first phase of the intervention, was positively correlated with the progress made during the intervention ( $r = .470, p = .001$ ). Consequently, the comparison method can be validated as an effective tool for improving comparison competency of high school students. Finally, Study 5 (Simon & Budke, 2023) showed that the use of the comparison method by the student groups during the intervention discussions was positively correlated (Spearman’s  $\rho = .412, p = .009$ ) with individual progress (differences between post- and pre-tests) obtained in Study 4, thus confirming that the comparison method is an effective tool for teaching comparison and increasing students’ comparison competency. Furthermore, Study 5 showed that solving the collaborative comparison tasks during the group discussions organised during the intervention was also positively correlated with the improvement in individual scores between the pre- and post-tests (Fisher’s exact test,  $p = .002$ , see Simon & Budke, 2023). However, Study 5 also highlighted the difficulties that students encountered during the intervention. The students, who were often used to closed tasks, found it difficult to break out

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<sup>4</sup> Links to consult the OER: In German: [https://www.ilias.uni-koeln.de/ilias/goto\\_uk\\_lm\\_4325913.html](https://www.ilias.uni-koeln.de/ilias/goto_uk_lm_4325913.html).  
In English: [https://www.ilias.uni-koeln.de/ilias/goto\\_uk\\_lm\\_4911773.html](https://www.ilias.uni-koeln.de/ilias/goto_uk_lm_4911773.html).  
In French: [https://www.ilias.uni-koeln.de/ilias/goto\\_uk\\_lm\\_4391846.html](https://www.ilias.uni-koeln.de/ilias/goto_uk_lm_4391846.html).

of their orientation towards solving tasks and finding the “right” answer and their “student job”, thus using avoidance strategies, in accordance with former findings on secondary students’ orientations (Breidenstein, 2006; Jiménez-Aleixandre et al., 2000; Martens & Asbrand, 2021; Perrenoud, 2013).

#### **5.4 Results relative to international comparison**

Studies 1, 2, 4 and 5 made it possible to obtain comparative results at international level on textbook comparison tasks’ suitability to enhance comparison competency and students’ proficiency in comparison competency (Simon et al., 2020; Simon & Budke, 2020, 2023, 2024a). These studies allowed to give more insight into all three research questions:

*“(1) How can we model and assess comparison competency in geography education internationally?”*

*(2) How competent are students while performing geographical comparisons?”*

*(3) To what extent can tools or scaffolds contribute to enhance comparison competency?”*

It allowed, thus, to answer to the comparative objectives of this dissertation which were to validate the assessment tool internationally, to study commonalities and differences between school systems, to assess students from different countries and also to test pedagogical resources which could be internationally valid.

Studies 1 and 2 allowed textbooks from England, Germany and France to be compared. Results showed that the typology of comparison tasks’ objectives and the model for comparison competency are valid for studying comparison tasks internationally, as the analyses confirm previous results in each country on tasks and textbook performance (Budke, 2011; Colin et al., 2019; Lee & Catling, 2017). The comparison competency assessment tool also proves to be valid for analysing the comparison competency of students from both Germany and France, as the results are in accordance with previous analyses of students’ performance in argumentation and reasoning in both countries (Budke et al., 2010b; Pallarès et al., 2020; Uhlenwinkel, 2015). Thus, the dissertation made it possible to provide the first validated and internationally tested instruments for the assessment of comparison competency.

Results from the textbook analysis showed common pitfalls in geography textbooks in the three countries, but also local differences. In Study 1, textbooks from England, which followed an



“enquiry-based” learning approach, did not differ much from the other countries in that they were also very content-oriented. Although textbook tasks tended to focus on only one type of comparison objective (Type 1), it was less the case for German textbook tasks than for textbooks from England and France. German and English textbooks tended to use more deductive and temporal comparisons, whereas French tasks tended to use more media literacy and inductive processes. French and English textbooks often used comparative tasks in case studies in order to be able to generalise in the lessons, thus using comparison as a didactic tool to generalise from an example. Other notable differences were observed in the development of comparison competency in the tasks (Study 2). English textbooks generally afforded students greater autonomy in selecting comparison elements, although tasks remained rather aimed towards reproducing geographical knowledge. French tasks primarily focused on enhancing argumentation to justify comparison results, thereby confirming the relatively low autonomy afforded to students in the comparison process in this country. German textbooks, in contrast, placed greater emphasis on tasks using variables and models in comparison to the other two countries. Consequently, both Studies 1 and 2 demonstrated the existence of distinct local textbook cultures in the different countries, reflecting the local disciplines’ cultures and orientations (Hericks & Körber, 2007; Pepin & Haggarty, 2001).

Studies 4 and 5 both demonstrated the validity of the developed assessment tool and the comparison method used as a teaching tool in Germany and France for assessing and enhancing students’ comparison competency. The intervention in Study 4 also showed that groups were comparable, and that differences in students’ performances in the pre-test were not statistically significant (intervention group:  $t(42) = 1.604$ ,  $p = .116$ , two-tailed; control group:  $t(37) = 1.302$ ,  $p = .201$ , two-tailed). This allowed both experimental and control groups to be constituted with students from both countries. Since group selection was controlled for different variables to ensure homogeneity, this confirms that the assessment tool and the comparison method are potential valid tools to be used internationally. However, both may need to be adapted locally for students with different educational or socio-economic backgrounds.

Finally, the use of the documentary method (Bohnsack, 2014; Bohnsack et al., 2013) in Study 5 demonstrated comparable orientations between French and German students, with regard to task completion and the pursuit of a “correct” answer during the collaborative task. This indicates the existence of a shared student culture in both countries (Martens & Asbrand, 2021; Perrenoud, 2013). Students from our tests in both countries employed evasion strategies in an attempt to avoid making a decision, and exhibited discomfort with the openness of the comparison task they were required to complete. Nevertheless, a few minor differences were

observed between French and German students, although these were not statistically significant. French students were more inclined to provide exclusive responses to the tasks, whereas German students employed more nuanced answers (Simon & Budke, 2023).

In conclusion, this dissertation has enabled the acquisition of preliminary theoretical approaches and empirical findings on comparison competency in geography education, with a view to establishing internationally valid approaches and results. In the following section, these results will be subjected to discussion.

## **6. Discussion**

This chapter will analyse and discuss the findings of this dissertation, contextualising them within the broader field of geographical education research. The dissertation opened with the observation that comparison competency has not been the subject of significant research within the field of geography education, despite its presence in both the scientific literature and in curricula. It was found that several gaps existed in this area of geographical education research. There was a need for more theoretical models for comparison competency in geography education that are valid on an international scale. Additionally, there was a need for more research into the manner in which comparison is present in geography textbooks and for an assessment of students' comparison competency. Finally, there was a need for educational resources to enhance this competency. In this section, I would like to discuss to what extent the dissertation's results provide initial responses to these research gaps. Firstly, thanks to the dissertations' theoretical models and empirical results, it could be demonstrated that comparison is already an important educational tool in geography education, but that comparison competency needs to be fostered (6.1). Secondly, I will assess how the dissertation's findings provide first theoretical approaches and insights for the analysis and promotion of comparison competency (6.2). Thirdly, I will address the dissertation's consequences for geography education: what is needed by teachers and in teacher trainings to enhance comparison competency and how the dissertation contributes to it (6.3). Lastly, these findings are reflected in their comparative and international dimension and directions for further developments in geography education research are outlined (6.4).

### **6.1 A first analysis of the extent to which comparison is present in geography education and of the necessity to enhance comparison competency**

This dissertation represents a first investigation into the existing geography textbooks' comparison tasks and the students' comparison competency in geography education. The theoretical approaches developed to conceptualise and assess comparison competency enabled first empirical results to be obtained, confirming that comparison is already present in geography education and that it has a variety of educational functions (6.1.1). The dissertation also demonstrated the necessity of fostering comparison competency, as the suitability of tasks for its enhancement and students' proficiency in comparison competency are frequently insufficient (6.1.2). Therefore, a theoretical proposition for steps to enhance students' comparison competency is outlined (6.1.3).

### **6.1.1. Comparison: already a fundamental educational tool in geography education**

This dissertation employed theoretical models to investigate empirically the presence of comparison in geography textbooks and the proficiency of students in comparison competency. The findings indicated that comparison is a fundamental element of geography education, serving a multitude of educational functions.

The findings of Study 1, which conducted a comparative analysis of comparison tasks in German, French and English textbooks, showed that comparisons are a frequent task, accounting for 9.18% of the total tasks in textbooks (Simon et al., 2020). This was also demonstrated by the diversity of comparison tasks' objectives and their distribution throughout the textbooks (Simon et al., 2020). Furthermore, the fact that comparison is a frequent task was corroborated by the observation that comparison tasks are not merely formulated using the command verb "to compare". Instead, comparison tasks employ a range of command verbs or *Operatoren* (Budke & Simon, 2021). All students in Studies 3 and 4 were observed to perform comparisons in the pre-tests and to write essays in response to the task from the assessment. This indicates that they were accustomed to engaging with comparison tasks (Simon & Budke, 2024a, 2024b). Study 3 demonstrated that the participants employed writing strategies previously utilised in secondary school, thereby underscoring the prevalence of comparison tasks and processes in secondary education (Simon & Budke, 2024b). Moreover, our assessments indicated that although their comparison competency is relatively limited in terms of the methodological dimensions, they demonstrated more advanced capabilities in the fourth dimension, which is oriented towards content and the achievement of comparison objectives. This suggests that they had developed a familiarity with comparison tasks and processes (Simon

& Budke, 2024b, 2024a). It can be seen, therefore, that comparison is a fundamental aspect of geography education and is identified by textbook authors as being crucial for knowledge acquisition. This is consistent with approaches from psychology which identify comparison as a “powerful tool” (Goldstone et al., 2010, p. 105), being one of children’s fundamental cognitive activities, which enables them to understand the world around them (Gentner & Namy, 1999; Gentner & Rattermann, 1991; Namy & Gentner, 2002). The increase in the number of comparison tasks with age is also consistent with studies that demonstrated that children's ability to compare increased with age and proficiency in the subject matter (Gentner & Rattermann, 1991). The inclusion in textbooks of numerous simple comparison tasks, which merely require students to articulate differences or similarities, is contingent upon the assumption that students possess a fundamental “comparative intuition” (Boswell et al., 2019, p. 1). In essence, comparisons constitute a significant aspect of geography education, with students frequently being required to engage in such tasks.

The classification of comparison tasks according to the typology of comparison tasks’ objectives revealed that a significant proportion of tasks (49.85%) pursue complex objectives that are analogous to scientific geographical objectives. The four principal objectives of comparison tasks (Type 1-4: Comparisons to build theory or differentiate case studies; Comparisons to apply or to test models; Comparisons to rank; Temporal comparisons, see Simon et al., 2020) mirror the multifaceted nature of scientific and geographical comparisons, as illustrated in Chapter 2 and in the literature (Azarian, 2011; Bartolini, 1993; Gervais-Lambony, 2000; Lijphart, 1971; Skocpol & Somers, 1980; Weber, 1921). As in the case of scientific and geographical comparisons, comparisons in geography textbooks serve a number of purposes, including the generalisation and formulation of concepts, processes or rules, the highlighting of the singularity of examples, the establishment of typologies or the verification of models. The predominance of induction objectives in the analysis (19,3% of all complex comparison tasks had a nomothetic objective, see Simon et al., 2020) is also consistent with the traditional conceptualisation of geography science processes as fundamentally inductive. (Harvey, 1969; Ritter, 1865; see 2.1.5). The incorporation of scientific processes and objectives (e.g., inductive processes to formulate laws or idiographic approaches) through comparison tasks in geography textbooks is a valuable pedagogical strategy that facilitates students’ learning and training in the various forms and objectives of comparison inherent to geographical science. The teaching of geographers’ comparison and, thus, scientific processes through such comparison tasks represents a means of imparting epistemic processes and methods from geography science, which is aligned with calls from research for the definition and promotion

of scientific literacy. In the existing literature and in the history of scientific literacy, three distinct visions of scientific literacy can be identified (Osborne, 2023; Roberts, 2007; Valladares, 2021). The first of these three visions, Vision I, asserts that the teaching of scientific content and processes is essential for the training of future scientists (Norris & Phillips, 2003; Roberts, 2007). Accordingly, the inclusion of scientific objectives within the dissertations' typology of comparison tasks' educational objectives aligns with Vision I of scientific literacy, which emphasises the transmission of scientific knowledge and processes, concepts and facts (Norris & Phillips, 2003; Osborne, 2023; Roberts, 2007; Valladares, 2021). This includes comparison processes, which are utilised in geography.

Furthermore, Study 1 demonstrated that the comparison objectives in current geography textbooks extend beyond the mere attainment of scientific objectives or the training of scientific methods. The typology of comparison tasks facilitated the identification of a specific type of task associated with the promotion of media literacy (Type 5, Comparisons to promote media literacy, see Simon et al., 2020). The educational function of comparison as a means of evaluating available sources and comparing them with one another allows for the expansion of a simple typology that would focus solely on scientific processes for acquiring knowledge, such as the inductive or the deductive method. It is important to note that geographical comparison is not merely the comparison of geographical units along variables; it also entails the gathering of data or information to facilitate the comparison. Geographers must subject their sources and data to rigorous scrutiny, evaluating their provenance and assessing their credibility. They must also compare their sources to identify the most useful for analysing a specific question. It is thus imperative that any geographical work incorporates a critique of the sources employed and the selection of documents available for comparison. Consequently, the presence of comparison tasks enhancing media literacy in textbooks, as identified in Study 1 (Simon et al., 2020), is a promising finding and aligns with other approaches of scientific literacy associated with a second definition of the term "scientific literacy", Vision II. The Vision II approach considers the social and cultural contexts of science education. In Vision II, scientific literacy is defined as a competency (Osborne, 2023). It is perceived as a means of training not only prospective scientists, but also individuals capable of evaluating scientific outcomes and comprehending contemporary political or societal discourses involving scientific matters (Valladares, 2021). These individuals may be characterised as "competent outsiders" (Osborne, 2023; Osborne & Pimentel, 2022). This means that students must be capable of identifying scientific achievements, understanding the epistemological processes and methods employed, utilising scientific knowledge to inform decision-making and action, and also being able to read, engage

with and critically evaluate scientific discourses and argumentations (Osborne, 2023). Those who advocate for Vision II of scientific literacy emphasise the importance of fostering the ability to evaluate scientific sources (Aikenhead, 2006; Norris & Phillips, 2003; Osborne, 2023). The scientific discourse is, on occasion, characterised by ambiguity, uncertainty and contradiction (Osborne & Pimentel, 2022). It is essential that students are able to evaluate scientific data that is not derived from textbooks and that has not been simplified for educational purposes. Chinn et al. (2023) argue that educational material and data are often presented in a manner that is excessively “epistemic friendly”. This implies that the data and information encountered in the real world, which students will be required to apply their scientific literacy in, is often vague, contradictory, and unreliable. Conversely, the scientific information provided in schools is characterised by a simplistic nature, which may be perceived as “friendly”. This phenomenon is also observed in textbooks, where the information is prepared, reduced, and selected, even when it is based on authentic sources (Lütje & Budke, 2021). It is therefore essential that any evaluation of the scientific content of these sources should be preceded by an ability to compare and evaluate the available sources. It is crucial to be able to assess the reliability of a source, particularly in the context of the vast amount of information available on the internet and on social networks (Osborne & Pimentel, 2022). This necessitates an understanding of the conditions under which this knowledge is produced. It is similarly important to recognise that, while scientific knowledge is occasionally uncertain, this does not necessarily imply that it is unreliable or untrustworthy (Osborne & Pimentel, 2022). It is therefore of great importance that one objective in comparison tasks should be to evaluate the geographical sources and documents available to students, as the typology of comparison tasks’ objectives demonstrated. The inclusion of Type 5 in the typology enables the consideration of more expansive comparison objectives than the mere training of scientific methods.

The findings of Study 1 indicate that textbook authors perceive comparison to be a fundamental pedagogical tool in the context of geography education. Firstly, comparison tasks may be designed with the sole intention of achieving simple educational objectives. Such tasks often refer to students’ everyday knowledge or simply reproduce existing knowledge. The utilisation of students’ own experiences or everyday knowledge in tasks can facilitate a constructivist approach to knowledge acquisition, enabling the integration of prior knowledge with new concepts (Karpov, 2003; Klein, 1995; Roberts, 2014; Wadsworth, 1996). Furthermore, the use of local examples has been linked to the increased relevance of scientific issues for students (Sadler, 2004). Additionally, simple reproductive tasks permit students to “acquire” knowledge, thereby providing them with access to a preconstituted knowledge base (Osborne, 2014).

Secondly, the dissertation demonstrated the close interrelation between argumentation and comparison. Argumentation is frequently required to justify the results of comparison tasks (24.1% of tasks, see Simon & Budke, 2020), which corroborates the orientation of tasks towards geographical content (Colin et al., 2019; Lee & Catling, 2017). Furthermore, the justification of results is frequently a pivotal element in tasks that require argumentation for scientific learning (Garcia-Mila et al., 2013; Garcia-Mila & Andersen, 2007; Sadler & Zeidler, 2005a). Finally, comparison remains a prominent rhetorical device, particularly in tasks that prompt students to evaluate an existing comparison as a premise and to respond to it in a constructive manner (Simon et al., 2020). Such comparison tasks are frequently designed to require students to justify the results of the comparison and to engage in discussion thereof (Simon & Budke, 2021). Such tasks are analogous to formulations from the classical *dissertation* form in the French school system or the “compare and contrast” essay in the English school system, indicating the enduring significance of comparison as a foundational rhetorical task associated with argumentation (Goyet, 2014).

These findings confirm that comparison is already a fundamental process in geography education. The current form of comparison tasks is already contributing to the fostering of comparison competency, which can contribute to the promotion of scientific (geographical) literacy. However, further enhancement of comparison competency is necessary.

### **6.1.2. The need to enhance comparison competency**

The empirical results obtained during the implementation of the theoretical models confirm that the potential of comparison is not realised by the comparison tasks in current geography textbooks and that the current level of many students is unsatisfactory. In light of the dissertation’s results on the suitability of textbook tasks and the low proficiency demonstrated by some students in comparison competency, fostering this competency seems necessary.

Despite the typology of comparison tasks enabling the diversity of educational functions of comparison to be identified, many of the comparison tasks analysed in Study 1 were not designed to develop complex objectives. A total of 50.15% of the comparison tasks were found to be merely simple tasks, designed to reproduce geographical content without any intention of fostering the development of geographical competencies (Simon et al., 2020). A common objective of comparison tasks is for students to reproduce geographical knowledge through the straightforward juxtaposition of comparison units and/or variables that have already been provided. Other simple tasks only relate to students’ everyday knowledge. The majority of

simple tasks do not afford students the autonomy to select comparison elements, such as units, variables, or materials, or to formulate a question to be solved. Only a small number of tasks provide sufficient support to ensure the acquisition of competencies. Tasks often do not facilitate genuine reflection on new knowledge, despite the fact that they should be designed to achieve higher-order objectives. These findings corroborate the assertion that textbooks are frequently content-oriented and do not prioritise competency acquisition (Budke, 2011; Colin et al., 2019; Lee & Catling, 2017). Furthermore, Study 1 demonstrated that the range of potential comparison tasks is not fully utilised in the textbooks, which frequently prioritise Type 1 inductive processes (Comparisons to build theory or to differentiate case studies, see Simon et al., 2020), despite the potential value in exploring other processes and objectives.

Study 2 could confirm that comparison tasks in French, German and English geography textbooks do not foster comparison competency in all its dimensions. Consequently, they fail to transmit the necessary methodological steps regarding comparison, such as the careful selection of comparison units, variables, material and data, and research question (Simon & Budke, 2020). There is a paucity of tasks that permit the autonomous selection of comparison elements. Subsequently, a significant number of tasks do not facilitate students' implementation of comparison processes (Dimension 1: Planning and Implementation of Comparison Processes). Furthermore, comparison tasks frequently fail to encourage the argumentative aspect of comparison competency (Dimension 2: Reflection and Argumentative Justification of Comparison Processes), as well as the third dimension (Dimension 3: Interrelation of Geographical Information), which are nevertheless crucial elements of comparison competency. It is only with regard to Dimension 4 (Dimension 4: Achievement of Comparison Objectives) that a proportion of textbook tasks were found to attain satisfactory levels.

Consequently, Studies 3 and 4 demonstrated that students exhibited a deficiency in the requisite proficiency in comparison (Simon & Budke, 2024a, 2024b). The results demonstrated a notable deficiency in students' ability to engage in comparison, particularly in the domain of argumentation. This corroborates the findings of Studies 1 and 2, which demonstrated that textbook tasks are ineffective in enhancing comparison competency due to their inability to foster higher-order thinking, with an emphasis on geographical content and comparison results (Simon et al., 2020; Simon & Budke, 2020). This is also in line with research results which also showed that students had difficulties while arguing (Budke et al., 2010b; Uhlenwinkel, 2015). It is evident that the students lacked the requisite training in the methodological dimensions of comparison competency, as evidenced by the analysis of the textbook. Consequently, they were often unable to achieve high results in these dimensions. Furthermore, Study 5 indicated that



during the intervention, student groups employed eviction strategies in an attempt to avoid solving the comparison task. This was likely due to their lack of experience with open tasks that afford students considerable autonomy and require the use of argumentation skills (Simon & Budke, 2023). This suggests that they were not adequately prepared to engage with complex comparison tasks.

The issues identified in the analysis of geography textbook tasks and students' comparison competencies can be attributed to a number of factors. Firstly, the act of comparison, as a complex task, process, method for geography education and complex competency, has not been frequently studied or researched, as demonstrated in Chapter 2. A limited number of research approaches were identified that were unable to fully capture the intricacies and potential of comparison processes in geography education. It appears that comparison is regarded as an inherent and self-evident process, one that does not necessitate explicit reflection as a distinct method or competency for geography students to exercise. This may be due to the fact that it is also a common everyday process and an unreflected basic cognitive function (Gentner & Namy, 1999; Goldstone et al., 2010). Thus, comparison is really part of a “didactic folklore” in geography education, as it is the case in German classes (Pflugmacher, 2018, p. 153). Moreover, the complexity of comparison processes has not been at the centre of geography education research until yet. Secondly, the theory-based definition of comparison (see Chapter 2), the model for the comparison method (Wilcke & Budke, 2019), the typology of comparison tasks' objectives, the comparison competency model and the assessment tool for comparison competency (Simon et al., 2020; Simon & Budke, 2020, 2024b) are all new research results that were developed after the textbooks' publications. Prior to these theoretical results, comparison was not conceptualised as a complex competency or a complex process that necessitates enhancement or scaffolding. Consequently, the approach was excessively “didactically reduced” towards elementary tasks, wherein all elements were provided to students for the attainment of content-oriented, simple objectives, as evidenced by numerous tasks from the textbook analysis.

Nevertheless, comparison in geography education represents a considerably more intricate and fascinating field of study, as evidenced in Chapter 2 of this dissertation. The utilisation of comparison represents a fundamental instrument, serving both methodological and content-related purposes. As defined in Chapter 2, comparison is a reflective and argumentative act, as well as a competency that entails the meticulous selection and justification of comparison elements, including the question, units, variables, and material used for comparison. It is essential to reflect on and justify each step of the comparison process, as the outcomes of

comparisons can vary depending on the selection of comparison elements and the choices made during the process. Consequently, comparison tasks included in textbook exercises are frequently incomplete, as they tend to provide all comparison elements but focus exclusively on the results. Furthermore, the lack of tasks that prompt students to engage in argumentation to justify and reflect on the comparison process is a significant issue. Students are deprived of the opportunity to reflect on the conditions that led to the comparison results. They are not accustomed to critically reflecting on their own comparison process or other comparison results and/or processes. This hinders the development of metacognitive competencies. This is problematic, since comparisons are not merely a matter of juxtaposition or a mere result; they are also a process (Wilcke & Budke, 2019). This process is worthy of interest and requires training and learning (Simon & Budke, 2020).

Comparisons are also a fundamental instrument for comprehending geographical matters and spatial disparities or challenges. To illustrate, in the subject studied in the digital learning unit developed during Phase 2 of this dissertation, comparisons are a valuable tool for understanding and contrasting current migratory processes with those of the past (see Appendix 1-4). In other subjects, such as development studies, the effects of climate change or globalisation processes, comparisons can assist in understanding these processes and how they may impact differently geographical places. Moreover, comparisons are fundamental to political decisions regarding the allocation of resources between competing spaces, which must be evaluated through comparison to determine the most appropriate distribution of funding. It can be argued that comparisons are fundamental to political discourse, decision-making and action. They can be employed as a means of justifying or explaining political decisions. It is essential that students are able to decipher such comparisons and are not unduly influenced by them. The findings of this dissertation indicate that the majority of tasks in geography textbooks do not facilitate the development of the competency to use comparisons to argue and take a position, or even to be able to make decisions on the basis of these geographical comparisons. This could be interesting in the sense of developing a “critical scientific literacy” as defined in Vision III of scientific literacy. In this vision, knowledge about scientific facts and methods, but also knowledge on the social and cultural contexts of scientific production are at the basis for student participation and citizenship realisation. This vision postulates that scientific literacy does not only entail Visions I and II but should also lead to students’ empowerment for collective and/or political engagement. (Hodson, 2011; Osborne, 2023; Valladares, 2021).

It can be concluded that comparison is a fundamental tool in geography education. Fostering comparison competency could contribute to the enhancement of scientific literacy and other

educational functions of comparison. However, comparison tasks frequently fail to facilitate the development of comparison competency and some students' current proficiency in comparison competency is markedly deficient in certain competency dimensions. Nevertheless, comparison represents a crucial instrument in the field of geography. It is therefore evident that there is a need to enhance students' comparison competency and to conduct further research into the most effective methods of doing so.

### **6.1.3. Steps to foster students' comparison competency**

As evidenced in the former sections (see 6.1.1 and 6.1.2), the practice of comparison is prevalent in school systems, yet its intricacies and particularities are not duly acknowledged. This highlights the necessity for more robust reinforcement of comparison competency. It is essential to foster comparison competency in students, as this allows them to both produce and assess comparisons. Furthermore, it enables them to construct arguments using comparisons on geographical and political current issues, including climate change and spatial inequalities. Additionally, fostering comparison competency can allow students to act as citizens in a collective or political action. In this sense, fostering comparison competency may be considered a potential contribution to the advancement of scientific literacy, as defined in a broad sense and in reference to the most recent approaches to this term (Osborne, 2023; Osborne & Pimentel, 2022; Valladares, 2021). In the following, I outline a series of proposed steps for the enhancement of students' comparison competency (see Figure 6).

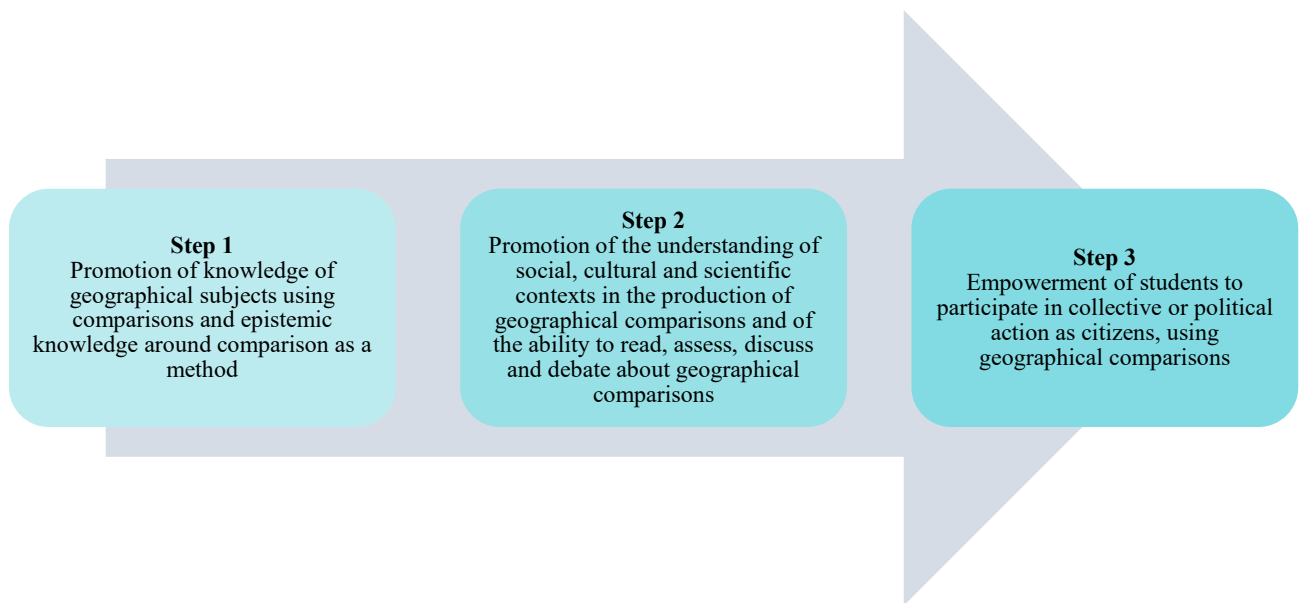


Figure 6: Steps to foster students' comparison competency. Own elaboration.

The distinction between these steps is based on the existing literature on scientific literacy, which can also be divided into three distinct “Visions” (Osborne, 2023; Roberts, 2007; Valladares, 2021, see 6.1.1 and 6.1.2). In the first step, the fostering of comparison competency entails the promotion of geographical subject knowledge through the utilisation of comparisons and epistemic knowledge pertaining to comparison, as a specific method with different steps. This aligns with Vision I of scientific literacy, which posits that scientific education should transmit scientific knowledge and methods in a unilateral manner, without consideration of the social contexts that shape the production of knowledge (Norris & Phillips, 2003; Roberts, 2007). This dissertation demonstrated that while current geography textbooks include tasks that assess different scientific objectives of comparison, many tasks fail to adequately train students in the methodological dimensions of comparison competency. Currently, Step 1 is therefore only partially achieved.

The second step in fostering comparison competency is to promote an understanding of the social, cultural and scientific contexts in which comparisons are made, as well as the ability to read, assess, discuss and debate geographical comparisons based on the knowledge gained in the first step. This aligns with Vision II of scientific literacy, which considers the integration of science within broader societal and political contexts and issues (see 6.1.1). This dissertation demonstrated that this step is only partially achieved through the presence in textbooks of tasks designed to train media literacy (Simon et al., 2020) and through the presence of some tasks fostering argumentation competencies (Simon & Budke, 2021). Nevertheless, the fact that comparisons can be debated is still not sufficiently encouraged. For instance, Study 5 revealed

that students were hesitant to take a stance or argue when seeking a common answer in response to a comparison (Simon & Budke, 2023).

In the third step, fostering comparison competency entails empowering students to engage in collective or political action as citizens, utilising geographical comparisons based on the preceding two steps. This aligns with Vision III of scientific literacy. The objective of Vision III is to cultivate a “transformative” scientific literacy and to encourage student participation and emancipation in the context of interdisciplinary, intersectional, and collaborative science education, while also critically reflecting on educational inequalities (Valladares, 2021). Hodson (2011) posits that scientific literacy should be harnessed to strengthen democratic processes and promote the realisation of informed citizenship. This “critical scientific literacy”, which underscores the political dimensions of science, is nevertheless founded upon the initial two visions and upon both derived and fundamental meanings of scientific literacy (Chinn et al., 2023; Osborne, 2023). Geographical comparisons have the potential to serve as effective political tools. International comparisons can inform political argumentation by highlighting the measures or policies that may be required to address inequalities. This dissertation has revealed a lack of resources in geography textbooks that facilitate this Step 3 in the enhancement of comparison competency. There is an urgent need for educational resources that can foster this step, which also requires the development of argumentation and action-taking competencies.

Consequently, as demonstrated by the use of the model for the enhancement of students’ comparison competency (see Figure 6) on the dissertation’s results, presently, only steps 1 and 2 of the enhancement of comparison competency are sometimes reinforced but would need further enhancement. Step 3 would also need to be addressed. These elements confirm the initially identified need for more research on comparison processes and comparison competency.

## **6.2 Reflection, interrelation and enhancement of the dissertation’s theoretical approaches of comparison competency**

This section will discuss how the dissertation’s theoretical models and empirical results interrelate and provide a first contribution to the analysis and the promotion of comparison competency. This dissertation presented and evaluated theoretical models for conceptualising and promoting comparison competency, which can be interrelated and further refined and enhanced by empirical results (6.2.1). Furthermore, the empirical results offer insights into the

potential for further enhancement of comparison competency through the promotion of language competencies (6.2.2).

### **6.2.1. (Enhanced) theoretical models to analyse and assess comparison competency**

To better conceptualise comparison competency, in Phases 1 and 2 of this dissertation, different theoretical models were constructed. These models allowed to better analyse comparison competency and they can be refined based on the empirical findings. In this section I interrelate and discuss the theoretical and empirical results obtained with the typology of comparison tasks' objectives (Study 1, Simon et al., 2020), the model for comparison competency (Study 2, see Simon & Budke, 2020) and the assessment for comparison competency (Study 3, see Simon & Budke, 2024b). Lastly, on the basis of this interrelation of theoretical and empirical results, I propose an enhancement of the comparison method for geography education proposed by Wilcke and Budke (2019), which formed the basis for these construction of theoretical models and served as a scaffold during Phase 3 (see 2.2.4).

Firstly, the typology of comparison tasks' objectives represents a robust and valuable tool for the evaluation of geography textbook tasks' objectives (Study 1, Simon et al., 2020). The different types of comparison objectives in textbook tasks are built in an inductive-deductive way and correspond to different types of geographical and scientific comparison. These include Type 1: Comparison to build theory or to differentiate case studies; Type 2: Comparisons to apply or to test models; Type 3: Comparisons to rank; Type 4: Temporal comparisons; and Type 5: Comparisons to promote media literacy. The typology has been demonstrated to be both valid and reliable (Simon et al., 2020). The results of Study 1 and the categorisation of textbook tasks' objectives into the typology permitted the conclusion that comparisons tasks from Type 1 (Comparisons to build theory or to differentiate case studies) are predominant in textbooks, while comparisons to build theory (Type 1.2.1: Nomothetic) are slightly more prevalent than comparisons to better specify cases (Type 1.2.2: Idiographic). This is consistent with the predominance of inductive processes in geography as a primary approach to knowledge construction, with deductive processes, typologies, and temporal comparisons being less significant (Harvey, 1969; Ritter, 1865). This confirms the relevance of the comparison method proposed by Wilcke and Budke (2019), which requires the formulation of a question to be addressed through the comparison process. The formulation of comparison objectives at the outset of the comparison process could enhance this method. However, Wilcke and Budke's

comparison method (2019) does not address the data utilised for comparison and the potential documents or sources available, which is a crucial aspect of the comparison process. The choice between possible units, variables, and even questions to be addressed may be influenced by this factor. The typology of textbook tasks presented in this dissertation identified this particular type of comparison between sources as an important category of tasks' objectives (Type 5: comparisons to promote media literacy, see Simon et al., 2020). Therefore, the material selected for comparison was included in the competency model for comparison competency, as part of the comparison processes (Study 2, see Simon & Budke, 2020) and as part of the comparison method used as a scaffold in the intervention (see Study 4, Simon & Budke, 2024a). It would be beneficial to enhance the initial model for the comparison method (Wilcke & Budke, 2019) with this additional element and include the selection of material and sources as part of the comparison process.

Secondly, the competency model for comparison competency is important for the conceptualisation of this competency. It has been demonstrated to be an effective tool for the categorisation of textbook comparison tasks into the levels of comparison competency, enabling the evaluation of tasks' suitability for its enhancement (Study 2, Simon & Budke, 2020). Furthermore, it serves as the foundation for the assessment tool which was used to assess university and high school students in Studies 3 and 4 (Simon & Budke, 2024b, 2024a). The results of the evaluation of textbook tasks' suitability for enhancing comparison competency and the assessment of students' performances yielded concordant findings. Geography textbook tasks were observed to often fall short of effectively developing comparison competencies within the three dimensions of comparison competency (Dimension 1: Planning and Implementation of Comparison Processes; Dimension 2: Reflection and Argumentative Justification of Comparison Processes; Dimension 3: Interrelation of Geographical Information, see Study 2, Simon & Budke, 2020). These are the same dimensions in which students often seem to require the greatest degree of support and where results were frequently low (Simon & Budke, 2024a, 2024b). Students who achieved high results in Dimension 1 did not explicitly utilise the comparison process when selecting comparison units, variables or material. This indicates that the competency was acquired, but not reflected, as evidenced by the low results in Dimension 2. In Dimension 3 of comparison competency, results were also frequently low, whereas they were more positive in Dimension 4 (Dimension 4: Achievement of Comparison Objectives), thereby confirming the content orientation of textbook tasks and the students' correspondingly better performances in this dimension. These results corroborate the content orientation of textbook tasks (Budke, 2011; Colin et al., 2019; Lee & Catling, 2017),

but also the frequently low competencies of students when using argumentation (Budke et al., 2010b; Pallarès et al., 2020; Uhlenwinkel, 2015).

Furthermore, the empirical findings indicated that the four dimensions of comparison competency are interdependent. Study 2 (Simon & Budke, 2020) demonstrated that dimensions 1, 2 and 3 are interrelated. As textbook tasks frequently lacked autonomy in terms of the selection of comparison variables, comparison units, and material or questions to be compared, students exhibited low performance in the initial dimension of comparison competency (Planning and Implementation of Comparison Processes) and the subsequent dimension (Reflection and Argumentative Justification of Comparison Processes). This was due to the fact that students were unable to justify these elements. In the absence of an enhancement of reflection on the comparison elements, tasks were unable to foster the third dimension of comparison competency (Interrelation of Geographical Information), which concerns the reflection and weighing of comparison elements in relation to each other. This finding was corroborated by Study 4 (Simon & Budke, 2024a). The results of this study indicate that, following the intervention, students demonstrated enhanced performance in all dimensions of comparison competency, which suggests an interdependence between the methodological and content-related dimensions of comparison competency. These findings are aligned with those of other research studies, which have also demonstrated the interrelation between methodological and knowledge outcomes in investigations involving geographical or scientific competencies or argumentation (Forkarth & Manzel, 2021; Khishfe, 2012; Means & Voss, 1996; Morawski & Budke, 2019; Sadler & Zeidler, 2005b). This interdependency could also imply a dual conditionality between the content-related and methodological dimensions of comparison competency (Kuckuck, 2014). If proficiency in the planning, implementation, reflection and justification of comparison processes is a prerequisite for the development of geographical content knowledge on and about geographical comparisons, then it follows that trained proficiency in the content-related dimensions of comparison competency must be available in order to plan, implement, reflect and justify comparison processes.

The double conditionality of methodological and content-oriented dimensions of comparison competency suggests that methodological and content-oriented elements are mutually dependent throughout the comparison process. The methodological steps involved in the comparison process are contingent upon the results obtained in the preceding step, and have ramifications for the subsequent steps. To illustrate, if one were to examine the differences in urban density between European countries, it would be necessary to define which variable is most appropriate for the measurement of “urban”. Adopting the French or German definition



of a city as the primary variable (i.e., a settlement with a population of more than 2,000 inhabitants in an urbanised area) would result in the exclusion of spaces designated as cities in Denmark (where the threshold is set at 200 inhabitants). Consequently, should one wish to include a Danish city in the comparison, it would be more accurate to consider other variables, such as the degree of urbanisation from the United Nations (2020). Therefore, the comparison process also necessitates the reevaluation of preceding steps in accordance with the content in question. The determination of content-related elements, such as comparison units or variables, can be subject to revision and consequently impact the process. It thus appears that the comparison method is not as straightforward as previously presented in the model by Wilcke & Budke (2019), and may require a more flexible approach to the presentation of the steps, with each step being conditioned by preceding steps.

Thirdly, the assessment for comparison competency (Study 3, see Simon & Budke, 2024b), which was theoretically based on the comparison competency model, enabled the comparison process to be defined with greater precision. In the course of the study, an additional item was incorporated into the assessment following the initial grading phase. This item was designed to ascertain whether students had produced a result for the comparison. The formulation of a result is an essential component of the comparison method and should be incorporated into the model proposed by Wilcke and Budke (2019). The result may vary depending on the weighting of variables. Additionally, justifications and explanations required to explain the results may vary depending on the weighting of variables and the results obtained.

Fourthly, the assessment of the use of the comparison method during Phase 3, during the intervention (Study 4, see Simon & Budke, 2024a) and group discussions (Study 5, see Simon & Budke, 2023) also provided insights into the efficacy of the comparison method as a didactic tool. The intervention enabled the implementation of a digital learning sequence comprising a variety of authentic materials and documents, which students were required to analyse in accordance with the steps of the comparison method<sup>5</sup>. Additionally, students were provided with worksheets structured according to the digital learning sequence. Tasks were formulated based on the comparison method steps, utilising a range of command verbs (see Appendix 1 and Appendix 2). The results of the individual use of the comparison method as a scaffold and the collective use during group discussions were found to be positively correlated with individual progress between the pre- and post-tests (see 5.3; Simon & Budke, 2024a). It can be

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<sup>5</sup> Links to consult the OER: In German: [https://www.ilias.uni-koeln.de/ilias/goto\\_uk\\_lm\\_4325913.html](https://www.ilias.uni-koeln.de/ilias/goto_uk_lm_4325913.html).  
In English: [https://www.ilias.uni-koeln.de/ilias/goto\\_uk\\_lm\\_4911773.html](https://www.ilias.uni-koeln.de/ilias/goto_uk_lm_4911773.html).  
In French: [https://www.ilias.uni-koeln.de/ilias/goto\\_uk\\_lm\\_4391846.html](https://www.ilias.uni-koeln.de/ilias/goto_uk_lm_4391846.html).

concluded that the explicit use of the comparison method may have a beneficial effect on students' abilities to make comparisons. The comparison method was thus validated as an effective tool for the promotion of comparison competency. Nevertheless, the analysis of group discussions conducted during the intervention phase of Study 5 indicated that students did not employ argumentation or reflection during certain stages of the comparison process. Additionally, the students encountered challenges since the comparison tasks did not yield definitive conclusions, despite some groups and individuals demonstrating effective reflection on the process. The results of Study 5 suggest that the openness of the comparison task may have caused difficulties for students who were accustomed to working with closed tasks and seeking a definitive or "right" answer. This means that in order for the comparison process to be successful, it is essential to ensure that the openness of the process is reflected. Furthermore, it is crucial to facilitate reflection on one's own competencies, feelings, and attitudes towards solving an open comparison task. Other studies have demonstrated the efficacy of such metacognitive strategies in overcoming learning difficulties (Ahmadi et al., 2013; Gebele et al., 2022) and in solving complex problems (Heuzeroth & Budke, 2021). Hasselhorn (1992, p. 42) proposes a classification of metacognition into five subcategories: systemic knowledge (encompassing knowledge of learning requirements, strategies and the cognitive system), epistemic knowledge (knowledge of one's own knowledge, memory states, readiness to learn), executive processes of control (including planning, controlling and monitoring of one's own learning processes), sensitivity (relating to experiential knowledge and intuition), metacognitive experiences (referring to the consciousness of one's own experiences and emotions). Wilcke and Budke (2019) incorporated elements of systemic knowledge through the reflection of all comparison steps. In view of the findings of Study 5, it would be worthwhile to consider incorporating elements encompassing other metacognitive subcategories, such as those related to self-reflection on one's knowledge of the method, emotions, attitude, or competencies.

Lastly, in light of these considerations, I propose that an enhanced version of the comparison method be employed (see Figure 7).

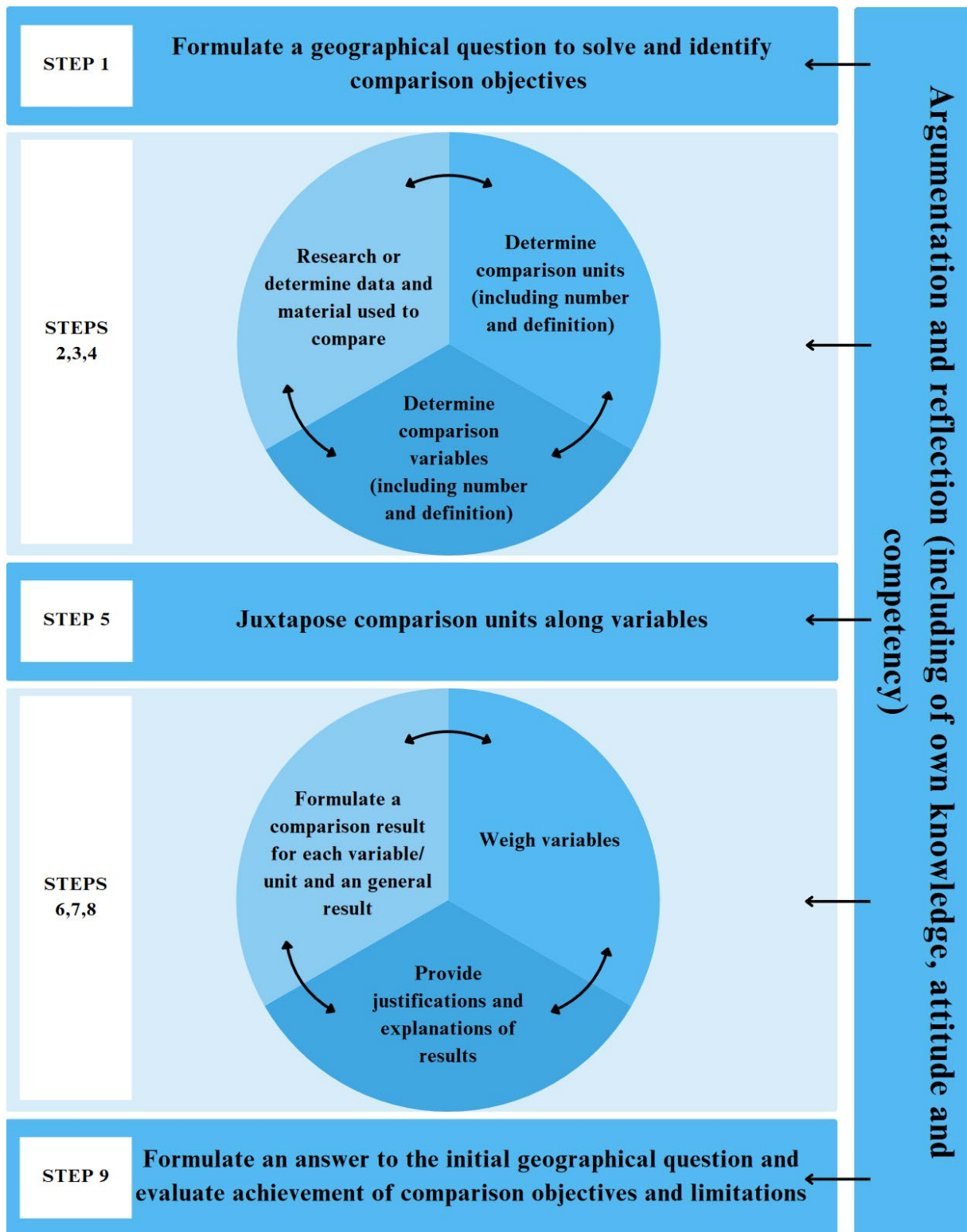


Figure 7: Enhanced model for the comparison method in geography education. Own elaboration after Wilcke and Budke (2019).

In this model, the initial step requires students to formulate a geographical question to be solved and to identify comparison objectives (within the range of objectives defined in Study 1, see Simon et al., 2020). Subsequently, as in the original model, in steps 2 and 3 students are required

to select and define the comparison units and variables (including the number of each), but now also in step 4 the material or data to be used for the comparison. The order of the aforementioned steps is not pre-determined and can be influenced by the content and the initial results of data selection. Consequently, these steps can be revised as necessary. It is possible to begin with the selection of data before selecting variables or units, or to start with units or with variables. All these steps have to be worked on. In the fifth step, as in the original model, students are required to juxtapose the comparison units along the variables. Furthermore, steps 6, 7 and 8 must also be completed, and the order in which they are undertaken may vary. Students must formulate a comparison result for each variable/unit and a general result, weigh variables, and provide justifications and explanations of the results. In the ninth step, students provide a definitive answer to their comparison and to the initial geographical question, and evaluate the success of their comparison objectives, including any limitations of their comparison on achieving these objectives or answering the question. At each stage of the comparison process, students must justify their methodological choices, the selection of comparison elements, and reflect on their understanding of the comparison process and any difficulties encountered while solving the comparison. This crucial interdisciplinary step is essential for fostering students' meta-cognitive abilities, which encompass the capacity to reflect on one's own knowledge, dispositions, and emotions in order to develop competencies.

The enhanced model was developed on the basis of all the different possible improvements that were presented previously, obtained after the implementation and testing of other theoretical constructs from the dissertation, which makes it theoretically and empirically grounded.

### **6.2.2. A possible promotion of comparison competency through the enhancement of language-related competencies**

Several findings of this dissertation can be interrelated and discussed since they indicate a correlation between language and comparison competency. It can thus be argued that the enhancement of language and argumentation competencies may prove an effective means of fostering comparison competency.

Results from Studies 3 and 4 revealed that students' comparison competency was often very low in Dimensions 1, 2 and 3 of the competency model (Dimension 1: Planning and Implementation of Comparison Processes; Dimension 2: Reflection and Argumentative Justification of Comparison Processes; Dimension 3: Interrelation of Geographical Information, see Simon & Budke, 2024b, 2024a). But, more specifically, they had difficulties

while arguing: they often only used argumentation to justify the comparison results. This is consistent with previous research findings that have also demonstrated the frequent use of argumentation for the purpose of justifying results (Garcia-Mila et al., 2013; Garcia-Mila & Andersen, 2007; Pallarès et al., 2020; Sadler & Zeidler, 2005a). The use of argumentation in school practices is frequently perceived as a mere vehicle for conveying factual information, rather than as an integral part of the process of producing results. Therefore, in Studies 3 and 4, students only rarely used argumentation to justify the selection of comparison elements such as comparison variables, units and material used to compare (Simon & Budke, 2024b, 2024a). This may be attributed to the fact that numerous comparison tasks do not facilitate the implementation of the comparison process, thereby limiting students' autonomy within this process. Assessment results demonstrated that students did not explicitly select the comparison elements, even when presented with an open task. Therefore, although the comparison elements were selected, this was not done consciously. Other findings have indicated that students frequently encounter difficulties when engaged in the production of argumentation (Budke et al., 2010b; Pallarès et al., 2020; Uhlenwinkel, 2015). It thus appears necessary to enhance Dimension 2 of comparison competency and the production of an argumentation to support the comparison process.

To achieve this, the results indicate that one potential approach to assist students in developing more effective comparisons and correspondingly stronger argumentations may be to focus on the language employed within the argumentative context and utilise pedagogical resources or scaffolds that are specifically oriented towards this aspect. In Studies 3 and 4, students were required to produce written argumentations, while in Studies 4 and 5, they engaged in group discussions on the subject matter while presenting their arguments orally (Simon & Budke, 2023, 2024b, 2024a). Two distinct configurations pertaining to language and argumentation were thus subjected to examination in the present dissertation, given that argumentations in geography classes may be produced, received, or discussed while engaged in interaction and may be oral or written (Budke et al., 2010a).

First, Study 3 sought to examine the diversity of comparison text structures and evaluate their quality. Additionally, it aimed to establish a correlation between the assessment of text structure and the results obtained from the comparison competency assessment. The findings indicated that students who produced more structured comparison texts demonstrated a higher level of proficiency in comparison competency (Simon & Budke, 2024b). The students (enrolled in a German university) frequently selected writing strategies from secondary school and German classes, where they may have been required as secondary students to compose essays based on

different materials. It is not unexpected that students would draw upon strategies from a different school discipline, given that other research has indicated that they are not frequently required to write texts in geography classes, with teachers instead focusing on writing tasks at the word or sentence level (Budke, 2021). Nevertheless, there was a moderately positive correlation between the quality of students' comparison text structures and their comparison competency. The utilisation of structured responses may have reflected a superior level of competency, but it is also possible that this approach facilitated the development or demonstration of greater competency. The use of different text structures was observed, with students who employed a clear structure generally obtaining higher scores than those who used a mixed structure. It can be concluded that there is a positive correlation between writing competencies and comparison competencies. This may be expected, given that comparison is also linked to language through rhetoric and argumentation, as previously observed. For example, the English "compare and contrast" essay, the French *dissertation* and in German classes the *Erörterung* are essays using comparison structures as rhetorical tools to defend a claim. The use of rhetorical and linguistic structures is an essential aspect of comparison, as it enables the communication of claims or results. Comparison competency can therefore be associated with communication competency.

Moreover, the findings of Study 5 indicated that participation in group discussions and the resolution of a comparison task within a group were associated with individual improvement between the post- and pre-test during the intervention (Simon & Budke, 2023). This is also consistent with other findings indicating that group discussions are conducive to the advancement of argumentation competencies (Johnson & Johnson, 1999; Osborne et al., 2004), even when students' answers were not pertinent (Knight et al., 2013).

These findings suggest a potential relationship between language competencies and comparison competency acquisition. This relationship may be evident in either written texts produced by the individual (production) or in group discussions (interaction). It is therefore possible that language-related activities may influence the development of comparison competencies. It can be argued that another potential strategy for enhancing comparison competency is the development of specific scaffolds and pedagogical resources oriented towards language and argumentation structures, in addition to the utilisation of the dissertation's theoretical models. Furthermore, other research findings indicate that writing can facilitate comprehension of complex interrelations (Sturm & Weder, 2022). The utilisation of writing and language strategies has been identified as a valuable tool for the advancement of argumentation and

geographical knowledge in other studies (Budke & Kuckuck, 2020; Kuckuck, 2014; Morawski & Budke, 2019).

As a consequence, language-based resources and scaffolds (Vygotsky, 1978) may prove an effective means of enhancing comparison competency. This dissertation has already identified certain elements that can enhance comparison competency through the utilisation of language-oriented resources and scaffolds. It may be of benefit to consider the language-related requirements associated with comparison, with reference to the model of language requirements developed by Morawski and Budke (2017, p. 64). One significant aspect that is specific to comparison is that the act of comparison is inherent to all languages and registers, including geographical language, school language, *Bildungssprache* and contained registers, as well as everyday language and the meta-cognitive layer of language. Nevertheless, as this dissertation has demonstrated, while everyday comparisons may provide a foundation for developing geographical comparisons, they are not sufficient in themselves. While some textbooks propose simple comparison tasks using everyday comparisons, meaningful comparison tasks necessitate the utilisation of the *Bildungssprache* and a more complex language (Budke & Kuckuck, 2017b; Gogolin, 2006; Habermas, 1977; Michalak et al., 2015). To undertake comparisons in the *Bildungssprache* and in the geographical language entails the capacity to process a substantial volume of information, to construct written comparisons with intricate structures and the use of precise vocabulary. Comparison competency, defined as the ability to produce and receive comparisons (see 2.2.5), was assessed and trained as a written task in this dissertation (Simon & Budke, 2024b, 2024a). But to compare can also be practised interactively in a group context (Simon & Budke, 2023). At the word level, the formulation of a comparison entails the utilisation of relationships of magnitude (e.g., “larger”, “more populated”, etc.). At the sentence level, the utilisation of specific linking words (e.g., “in comparison with”, “unlike”, “such as”, etc.) enables the construction of comparative sentences. At the text level, to compare implies the construction of paragraphs or arguments that contrast the units being compared. In addition, it requires the construction of logical paragraphs and the selection of an appropriate structure. This dissertation examined first ways in which scaffolds enhancing language-related competencies can be utilised to enhance comparison competency. Firstly, at the text level, different possible comparison text structures were categorised in Study 3 (Simon & Budke, 2024b). At the sentence level, sentence connectors expressing comparison were evaluated using the assessment tool for comparison competency. Secondly, during the intervention and Study 5 (Simon & Budke, 2023), group discussions were structured using task sheets which employed a variety of command verbs and scaffolding techniques, including the use of formulation aids

(see Appendix 3 and Appendix 4) at the sentence level. The results demonstrated that groups who engaged in discussion showed an enhanced comparison competency, as compared to groups that did not participate in discussions and thus did not utilise the task sheets.

### **6.3 Consequences for geography education: the dissertation's first contributions to the promotion of comparison competency**

This section proposes to draw the consequences of the dissertation's theoretical and empirical results for geography education. To enhance comparison competency, teachers need to be provided with tools and also follow specific steps (6.3.1). On the basis of these steps, it is then evaluated to what extent the dissertations' theoretical and empirical results first contribute to provide tools for teachers to enhance comparison competency (6.3.2). Finally, first guidelines for teachers to implement teaching sequences aiming to develop comparison competency are proposed (6.3.3).

#### **6.3.1. Steps for teachers to enhance comparison competency**

In the first section of this discussion (see 6.1), the need to foster comparison competency was identified and steps for its enhancement were proposed. However, these steps can only be attained if teachers implement them and if they dispose of tools to do so. To understand what teachers do need to plan and implement to foster comparison competency, theoretical approaches for the development of scaffolds (Gibbons, 2002; Vygotsky, 1978) and Kattmann's model for didactic reconstruction (Kattmann, 2007) can be of use. Gibbons (2002) distinguishes between two categories of scaffolding techniques: micro- and macro-scaffolding. While micro-scaffolding pertains to the interaction in the classroom, macro-scaffolding concerns the preparation of the learning sequence. Furthermore, Gibbons (2002) outlines three stages for the development of scaffolding and resources. In a first step, the linguistic requirements of the subject-specific content to be taught are to be identified. Secondly, the students' linguistic abilities are identified. In a third step, results from the first two steps inform the preparation of the class accordingly. Additionally, Kattmann (2007) conditions the conception of a teaching sequence to both the integration of disciplinary content and of students' representations. On the basis of these elements, different steps can be defined that teachers need to implement to promote comparison competency (see Figure 8).



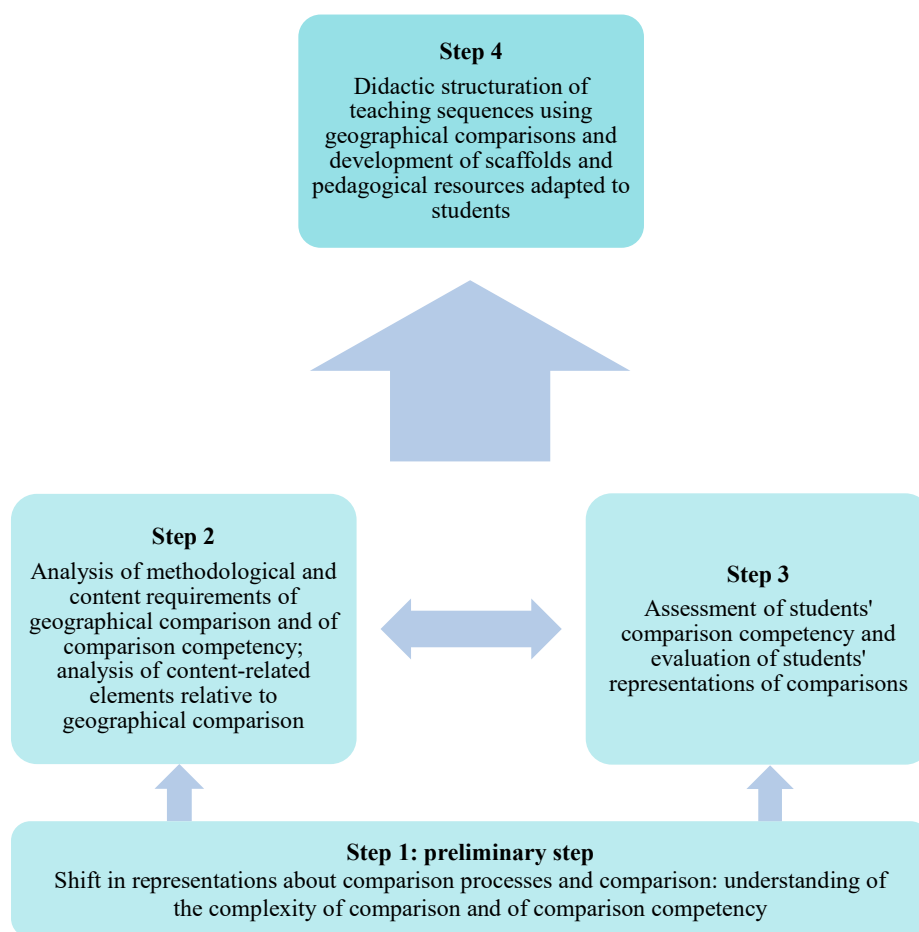


Figure 8: Steps for teachers to promote comparison competency. Own elaboration after Gibbons (2002) and Kattmann (2007).

In a first and preliminary step, it seems fundamental that teachers understand the complexity and peculiarity of comparison processes, of comparison as a method, and of comparison competency. The dissertation could show (see 6.1) that comparison, although present in school systems, is not reflected as such. There is, therefore, a need for teacher training and in-service training to contribute to this shift in the representations towards comparison and to provide teachers with the necessary tools, so that they can develop teaching sequences or comparison tasks using the diversity and potentialities of comparison.

In a second step, it is essential that teachers identify and analyse the requirements of comparisons and of comparison competency and also analyse and gather elements related to the subject matter, i.e. to the specific geographical comparison. This means that they need to have access to scientific knowledge and models concerning comparison and comparison

competency, on top of realising the more expected scientific analysis relative to the geographical content.

In a third step, teachers have to be able to assess their students' competency and gain insight on students' representations of comparison as a method and as an open task. This means that teachers have to get access to assessment instruments for comparison competency, as well as to the results of research regarding students' representations and orientations.

Finally, in a fourth step, teachers need to construct their own learning sequences, documents and teaching materials adapted to their students. This means that they need access to tested tools, tasks and examples of good practice. This also means that they have to get guidance on how to develop possible other pedagogical tools or strategies.

The following sections will present a discussion of the dissertation's contribution to provide results and tools to attain steps in the steps for teachers to enhance comparison competency (see Figure 8) and also evaluate which steps can also be achieved in the steps to enhance students' comparison competency (see Figure 6).

### **6.3.2. Contribution of the dissertation's theoretical models and empirical results to the enhancement of comparison competency**

The typology of comparison tasks' objectives (Study 1, see Simon et al., 2020) can assist educators in becoming aware of the potential comparison objectives. It serves as an important tool for the deliberate utilisation of simple comparison tasks, initially to facilitate students' initial discovery and comprehension of concepts, potentially situated within their everyday experiences, before progressing to more complex inquiries and tasks. It can also help identify complex comparison task that may prove beneficial within a learning sequence. Furthermore, the competency model for comparison competency (Study 2, see Simon & Budke, 2020) can help teachers understand the complexity of comparison and of comparison competency. Such an approach can assist educators in understanding the argumentative dimension of comparison competency, thereby potentially enabling them to specify the requisite elements of comparisons. Consequently, both models can assist teachers in steps 1 and 2 (understanding of the complexity of comparison and identification of the requirements of comparison) of the steps for teachers to enhance comparison competency (see Figure 8). Furthermore, the typology of comparison tasks' objectives can assist educators as a theoretical orientation in formulating comparison tasks or modifying existing simple tasks in textbooks into more complex

comparison tasks. This can be helping teachers in step 4 of the steps for teachers to enhance comparison competency (see Figure 8).

Both the typology of comparison tasks' objectives and the competency model for comparison competency (Studies 1 and 2) can be employed as the basis for the development of robust instruments that foster the development of a scientific geographical approach. The variety of scientific objectives included in the typology of comparison tasks' objectives also permits the achievement of didactic objectives that extend beyond the mere discovery of scientific procedures. For example, the relevance of documents or sources can be evaluated through the implementation of comparison tasks. The argumentative dimension of comparison, as evidenced in the model for comparison competency (Dimension 2: Reflection and Argumentative Justification of Comparison Processes) allows to produce comparisons contingent on their production context. Accordingly, both models can be used as a foundation to achieve steps 1 and 2 of the model to enhance students' comparison competency (see Figure 6).

The assessment tool for comparison competency (Study 3, see Simon & Budke, 2024b) can be used by educators to evaluate students' comparison competency and monitor students' progress. Furthermore, it can be employed to differentiate between students' levels, thereby providing a crucial foundation for the development of differentiated pedagogical resources within a given group. The assessment tool for comparison competency is also a valuable instrument for educators to assess students' linguistic abilities while comparing, prior to planning a geography learning sequence that involves comparisons. The tool assesses not only students' comparison competency but also their language-related abilities while comparing. Therefore, it can help teachers with step 3 (assessment of students' comparison competency) of the steps for teachers to enhance comparison competency (see Figure 8). Furthermore, results from Study 5 (Simon & Budke, 2023) gave insights on students' representations about comparison and comparison tasks, which can also help teachers in step 3. Additionally, the assessment can serve as a basis for a scaffolding tool, in the form of a checklist, so that students assess their own comparisons, and as a guide for the structuration of comparison texts. More generally, scaffolding tools developing language-related competencies can contribute to step 4 (development of scaffolds and pedagogical resources adapted to students) of the steps for teachers to enhance comparison competency.

Finally, the comparison method (see Figure 7) is a also highly valuable tool. Its efficacy as a potential scaffold during the intervention has been demonstrated in Studies 4 and 5 (see Simon & Budke, 2023, 2024a). It makes explicit the method of comparison and it may serve as a model

for students, presented either as an explicit checklist or as a reminder of the various comparison steps. This can reinforce their methodological knowledge while planning or practising comparisons. Thus, it can contribute to the enhancement of the teaching of scientific methods, and similarly demonstrates the particular characteristics and production contexts of comparison processes, which must be reflected in the transversal step of the method. Therefore, it is a highly significant potential scaffold to enhance comparison competency in steps 1 and 2 of the steps to enhance students' comparison competency (see Figure 6).

Moreover, the comparison method can assist teachers in comprehending the intricacies and particularities of comparisons. It enables educators to devise learning sequences that utilise comparisons or comparison tasks. For instance, teachers may choose to allocate instructional time in accordance with the comparison method's prescribed steps or utilise it as a foundation for the creation of worksheets incorporating a range of command verbs that emphasise distinct comparison phases. Therefore, this model contributes to step 1 (understand comparison) and step 4 (development of teaching sequences using geographical comparisons and of scaffolds) of the steps for teachers to enhance comparison competency (see Figure 8). Furthermore, the results from the utilisation of the comparison method during the intervention can serve as a basis to provide teachers with knowledge on the students' representations about comparisons. It should be noted that students are not accustomed to open comparison tasks, in which the elements of comparison and the results obtained must be argumentatively justified and reflected. This has to be taken into account in step 3 (evaluation of students' representations of comparisons) of the steps for teachers to enhance comparison competency (see Figure 8).

By fostering language-related competencies, it is possible to contribute to the steps 1 and 2 of the steps to enhance students' comparison competency (see Figure 6). This may also provide a foundation for the improvement of step 3, while assisting students in developing arguments through comparisons and in employing comparisons to defend their opinions argumentatively. The dissertation's results on the interrelation between language-oriented and comparison competencies can also serve as a basis for the development of further tools and contribute to step 4 in the model for teachers to enhance comparison competency (see Figure 8).

To conclude, the fostering of comparison competency can be achieved through the utilisation of pedagogical resources that are structured in accordance with the theoretical constructs and empirical results of the dissertation (including the typology of comparison tasks' objectives, the comparison competency model, and the assessment tool for comparison competency (Simon et al., 2020; Simon & Budke, 2020, 2024b). Additionally, the model of the comparison method, which was tested, validated in the Phase 3 of the dissertation (Simon & Budke, 2023, 2024a)

and enhanced in this discussion is also a very valuable contribution to this promotion of comparison competency, both for teachers and for students.

### **6.3.3. First guidelines to develop learning sequences and/or tasks aiming towards comparison competency enhancement**

This dissertation has identified the shortcomings of current textbook tasks in terms of their frequent lack of suitability to enhance the development of comparison competency. Having identified the dissertation's contribution to the steps to enhance students' comparison competency (see Figure 6) and to the steps for teachers to enhance comparison competency (see Figure 8), the following guidelines can now be proposed for teacher training or for teachers to develop learning sequences using geographical comparisons and fostering comparison competency. The steps for these guidelines are based on Figure 8, the scaffolding steps proposed by Gibbons (2002), and the model of the didactic reconstruction (Kattmann, 2007). Based on these approaches, the guidelines consider the content, subject-specific methodological and language-oriented requirements, as well as students' abilities and perspectives, prior to planning the learning sequence and adapting the material.

- 1) Firstly, as presented in Figure 8, teachers must comprehend the nuances and complexities associated with comparison processes and the development of comparison competencies. Such an approach may necessitate a shift in the way they understand comparison.
- 2) Secondly, educators must identify the precise content-related and language-related requirements of the comparison that students are required to perform. This may be achieved through the utilisation of the enhanced model for the comparison method, the typology of textbook tasks' objectives, the competency model and the assessment tool for comparison competency (Simon et al., 2020; Simon & Budke, 2020, 2024b).
- 3) Thirdly, the assessment tool for comparison competency (Simon & Budke, 2024b) can be used as a basis for teachers to evaluate students' comparison competency. Study 5's results on students' orientations can be used for teachers to get knowledge on students' representations of comparison (Simon & Budke, 2023).
- 4) Fourthly, on the basis of this, educators need to develop meaningful tasks or activities that will enable students to autonomously develop their own comparisons. Educators may utilise the comparison method as a pedagogical tool to allocate teaching hours, to

scaffold their students' learning, or alternatively, they may develop comparison tasks in accordance with the prescribed steps.

- Comparison tasks must be formulated in an open manner, thereby requiring students to select their own comparison units and/or variables and justify their choices.

- Various differentiation strategies to address differences between students' proficiency can be adopted. It is possible to provide students with a list of variables and require them to select and fix the units (or vice versa) to be compared, with the understanding that these steps can be completed separately. It is also possible to structure the task while scaffolding it, maybe on the basis of the comparison method, as proposed during the intervention (Simon & Budke, 2024a).

- It seems advisable to utilise the diversity of possible command verbs (*Operatoren*), as is sometimes already the case (Budke & Simon, 2021), in order to render the comparison task genuinely complex and to provide guidance to the students. As demonstrated in this dissertation, a multitude of tasks are already present in textbooks. It is possible to develop or adapt these tasks to enhance their interest and complexity, following an analysis of their objectives using the typology of textbook tasks or the comparison competency model (Simon et al., 2020; Simon & Budke, 2020).

- The material to use in the comparison task has to be carefully reflected by teachers and by students. The material can be provided to students in an "epistemic friendly" manner (Chinn et al., 2023), or students can conduct their own research and reflect on the sources they find in order to perform the comparison and evaluate them using a comparison task that aims to train media literacy, as outlined in the typology of comparison tasks' objectives (Type 5: Comparisons to promote media literacy, see Simon et al., 2020).

- Tools designed to facilitate the development of comparison and argumentation competencies, or those aimed at enhancing language-related abilities, can be differentiated according to students' levels and specific difficulties. Furthermore, scaffolding can be provided in a sequential manner, contingent upon the specific comparison steps involved. It is possible to distinguish between content- or methodology-oriented scaffolds and language-oriented scaffolds, as this approach has been shown to be beneficial in other studies (Budke & Kuckuck, 2020). As said before, it may therefore be beneficial to provide the assessment tool for comparison competency in the form of a checklist, enabling students to evaluate their own performance before

being offered the comparison text structure and linguistic scaffolds as a guide to writing the comparison results at a later stage.

- The tasks should be diverse and not solely focused on written comparisons. The incorporation of group discussions or other pedagogical strategies that utilise language-related competencies can also prove beneficial (Simon & Budke, 2023).

- 5) Fifthly, teachers must ascertain that students engage in self-reflection on their performance and the comparison process, as well as employ meta-cognitive strategies, so they have to integrate these elements into the learning sequence. This may be accomplished either at the initial assessment of the students or during the course of the learning sequence. It is essential that students are aware of their own competency development; tasks or scaffolds must therefore be explicitly explained. Reflection on the comparison results and processes has to be done at each step of the comparison method, i.e. possibly at each step of the learning sequence or of the comparison task with specific dedicated tasks.
- 6) Finally, it is essential to plan comparison competency training through comparison tasks on a long-term basis. As evidenced by Study 5, students encounter challenges when confronted with open tasks that do not adhere to a singular, definitive answer and necessitate the articulation of a coherent argument. This is due to the fact that the outcome of such tasks is not always fixed, but rather contingent upon the choices made during the comparative process. For these students, an open task represents a shift in the established norms of task culture and a redefinition of their “job” as learners. (Luhmann, 1990; Perrenoud, 2013; Simon & Budke, 2023).

#### **6.4 Consequences for geography education research: reflection on the dissertation’s own comparison and possible directions for future research**

This section presents the implications of the findings presented in the dissertation and the subsequent discussion on these findings for research in the field of geography education. The dissertation proposed a first international comparative analysis of comparison competency, which expands the possible validity of developed approaches and needs to be reflected (6.4.1). Furthermore, the results and discussion allow for the identification of potential areas for further research, which could be conducted in order to enhance or expand the research questions related to comparison competency (6.4.2).

#### **6.4.1. Reflection on the dissertation's own comparative and international approach of comparison competency**

Four studies from this dissertation adopted a comparative approach (Studies 1, 2, 4, 5; (Simon et al., 2020; Simon & Budke, 2020, 2023, 2024a). The comparative approach enabled the development of theoretical models with international validity, including the typology of comparison tasks' objectives, the competency model for comparison competency, and the assessment tool for comparison competency. The empirical results provided insights into the similarities and differences between geography textbooks from France, England and Germany with regard to their suitability for enhancing comparison competency and into the commonalities and differences between French and German students who participated in the intervention in Phase 3 of the dissertation. Different discussion points emerge from these studies and results regarding the international comparative approach.

Firstly, our validated theoretical models and tools represent a preliminary response to calls for more assessment in geography education and for tools which are valid on an international scale (Bourke & Lane, 2017; Bourke & Mills, 2022; Chang & Kidman, 2019; Kidman & Chang, 2022; Lane & Bourke, 2019). Moreover, while numerous researchers and academic institutions advocate for curricula that enhance scientific literacy as a means of addressing contemporary challenges (Lang et al., 2021; Osborne, 2023; Osborne & Pimentel, 2022; Sjöström & Eilks, 2018; UNESCO, 2020), although international tests to test international students' scientific literacy are developed (OECD, 2023) and although comparison is part of the scientific repertoire and methods (see Chapter 2), until now, how the enhancement of comparison competency could contribute to fostering scientific literacy internationally was not much researched. This dissertation and its results represent an initial step towards this reflection, as the results are valid beyond the national level. The promotion of comparison competency in textbook tasks and students' proficiency in comparison competency are subject to common pitfalls and problems. These present opportunities to design common general curricular orientations at a European level regarding the promotion of comparison competency and to validate pedagogical tools to promote it, such as the comparison method. Recent discussions have focused on the potential integration of geography into international assessments (Bourke & Lane, 2017; Lane & Bourke, 2017). It is proposed here that the assessment tool for comparison competency can provide a basis for assessing geographical comparison competency on an international scale. But, some limitations have to be taken into account. International assessments often require standardisation in assessment and the utilisation of



concise items that do not necessitate the composition of an essay. In contrast, the task and assessment tool for comparison competency were designed to be complex in this dissertation. Comparison competency necessitates the utilisation of sophisticated argumentative and language-related competencies, which are not readily quantifiable through the utilisation of standardised items. Furthermore, even if the assessment tool for comparison competency were to be validated in a European context, it may be necessary to adapt it to other contexts in order to guarantee fairness, given that comparison may be conceptualised or expressed in different ways in other cultural contexts. So, the dissertation provides a first attempt to assess internationally a complex geographical competency but implementing this assessment would need further precautions and reflection, as other authors already discussed regarding geographical competencies (Lane & Bourke, 2017).

Secondly, the results of the comparative approach demonstrate that the four studies exhibit both commonalities and differences between the various countries, indicating the presence of general tendencies while also highlighting local specificities. When considered as a whole, the results indicate a greater prevalence of similarities than differences. This is primarily attributable to the selection of comparison units, which were relatively comparable, as all selected countries were European Western countries and student groups were selected after controlling for other variables. However, the differences revealed by the studies also indicate the diversity of local situations and the specificities of national or regional school systems, pedagogical approaches and traditions. In this instance, the mixed-methods embedded design adopted in Phase 3 of the dissertation permitted the implementation of a “thick” comparative approach. This entailed the utilisation of a general quantitative approach in Study 4 (Simon & Budke, 2024a), which demonstrated the existence of commonalities between the experimental and control groups (which could be constituted despite their provenance from different countries). This was followed by a more specific qualitative approach in Study 5 to explore possible local differences. In Phase 3 of the dissertation, even if in the quantitative and qualitative analysis, French and German groups tended to have similar results and similar collective orientations, some specificities related to the nature of discussed answers showed also local specificities and nuanced the commonalities observed. The comparative approach was, therefore, also “methodologically” comparative, with a first generalising quantitative approach of groups that was nuanced by a more qualitative specifying idiographic approach. This is also what defines “thick” comparisons in anthropology: the “oscillation” (Candea, 2018) between commonalities and differences allow for the construction of a more complex result for the comparison, thereby making it become genuinely comparative.

#### **6.4.2. Possible directions for further research in geography education**

This dissertation presents an initial approach to the analysis, assessment and promotion of comparison competency in geography education. Furthermore, it has identified numerous possibilities for the further development of research on comparison in geography education. The findings from the various studies and the ensuing discourse on these findings indicate that comparison is a prevalent activity in geography classes. However, it is evident that comparison competency is not sufficiently developed and requires further enhancement. A three-step model was developed to conceptualise the enhancement of comparison competency in relation to the different Visions of scientific literacy (see Figure 6). The theoretical models presented in this dissertation provide a potential framework for the assessment of comparison competency and the development of scaffolds to facilitate its promotion. The dissertation presents a series of scientific theoretical tools that have been tested and validated, and which can be employed as a basis for the development of pedagogical material by geography teachers in geography classes. Furthermore, the promotion of argumentation and language-oriented competencies appears to be a crucial element in the enhancement of comparison competency. In light of the aforementioned discussion, it appears that the dissertation provided tools that facilitate the advancement of both Step 1 (the promotion of geographical subject matter through the utilisation of comparisons and epistemic knowledge surrounding comparison as a methodology) and Step 2 (the advancement of an understanding of social, cultural and scientific contexts in the production of geographical comparisons, as well as the capacity to read, assess, discuss and debate about geographical comparisons) of the proposed model for the enhancement of students' comparison competency (see Figure 6). Another model presenting the steps for teachers to enhance comparison competency presented a possible process for teachers and teacher trainings to follow (see Figure 8). The dissertation's theoretical and empirical models also allow to attain different steps in these steps for teachers to enhance comparison competency. However, in light of these elements, different research directions could be taken which would serve to reinforce, corroborate and extend the findings of the dissertation to better analyse and enhance comparison competency.

One possible direction for further research would be to refine, replicate and/or consolidate the findings of the dissertation while conducting additional interventions or analyses. So that teachers can implement the steps to enhance comparison competency, it would be necessary to further analyse their implementation of comparison in geography education. Investigating

teaching practices and teachers' representations, could help to design teacher training programmes and better identify training needs regarding step 1 of the model for teachers to enhance comparison competency (see Figure 8). To help teachers implement step 4 of this model, a further direction for research would be to test methods of fostering greater comparison competency by adapting and transforming the theoretical models into tools to be used in class. It could be, for example, while designing activities selectively promoting the different dimensions of comparison competency. It would be beneficial to compare the efficacy of other interventions utilising immersion strategies (Cavagnetto, 2010) to the mixed approach employing explicit strategies, which was employed during Phase 3 of the dissertation (Simon & Budke, 2024a). The provision of additional scaffolds and pedagogical tools would address the requirement to enhance argumentative and language-oriented competencies, thereby promoting comparison competency. These tools would require further development and testing. As an illustration, the assessment instrument for comparison competency (Simon & Budke, 2024b) could be evaluated in teacher training courses to assist educators in understanding and utilising it, and in secondary education settings to assess its efficacy as a tool to facilitate the development of comparison competency. This is also the case for the enhanced model for the comparison method, which was proposed in the dissertation's discussion (see Figure 7). The efficacy of the comparison text structures in relation to comparison competency also requires testing and evaluation. Research in discourse analysis and language teaching has indicated that text structured around variables or clusters of variables is more efficient (Spivey, 1991). It would be interesting to determine whether this is also the case for geographical comparisons. A further significant area for investigation in geography education research in relation to linguistic scaffolds would be the testing of textual and linguistic tools designed to assist students in the composition of comparisons. One potential solution is the use of model texts, which have been demonstrated to be effective in other contexts (Gallagher, 2011; Serwene, 2017). The efficacy of these pedagogical tools could be evaluated through linguistic and geographical research.

Secondly, the empirical results presented in this dissertation require further investigation in relation to their geographical content and the geographical dimension of comparison. The typology of comparison tasks' objectives was validated in this dissertation as an analytical instrument for evaluating the suitability of textbook tasks in geography textbooks (Simon et al., 2020). In addition to identifying the comparison objectives and classifying tasks into the five types, the scalar dimension of comparison was also explored, as it was hypothesised that this may be a specificity of geography comparison tasks. The concept of scale is fundamental to the

discipline of geography (Uhlenwinkel, 2013). It is also a prominent feature of geography education, with case studies at the local scale and generalisations at the larger scale being regularly alternated in French or English curricula (Department for Education and Skills & Qualifications and Curriculum Authority, 2004; Ministère de l'Éducation Nationale, 2019a). The empirical results indicated that the scalar dimension of comparison tasks was occasionally present, particularly in French comparison tasks (12.91% of comparison tasks), with comparisons utilising units with different scales (i.e., a process in a region compared to the same process at a global scale). Nevertheless, the possibility of comparing different scales did not appear to be fully exploited in the context of comparison tasks. A comparison of different scales may also entail a comparison of the perspectives from which they are approached. In the process of determining the distribution of resources, the utilisation of a scalar approach can prove to be a pivotal and conclusive element in the decision-making process (Vasiljuk et al., 2022). Further research could investigate the competency of students in making scalar comparisons and the ways in which this specific comparison of different scales can be fostered during argumentation. Another direction of research could investigate the specificities of geographical comparisons in geography education material or textbooks. In the textbook task analysis, the focus was placed on the objectives of comparison tasks. However, further investigation into the thematic orientation of comparison tasks would also be beneficial, particularly in an international context. For instance, it would be worthwhile to analyse whether there are particular topics where comparison is frequently employed, or whether specific comparison units and/or variables are preferred by textbook authors from different countries when associated with comparison tasks.

Thirdly, the investigation of comparison competency, defined as the ability to assess pre-existing comparisons and discourses or argumentations including comparisons, is a necessary step. The dissertation presented a model of comparison competency and an assessment tool oriented towards the production of geographical comparisons. However, comparison competency, as defined in Study 2, also encompasses the reception of comparisons, that is to say, the capacity to comprehend and assess comparisons (Simon & Budke, 2020). Of the tasks involving argumentation, a certain proportion (11.8%) involves evaluating and receiving a comparison that has already been carried out, and commenting on it (Simon & Budke, 2021). Comparisons are a common feature of both scientific and political discourse, occurring frequently in the analysis of inequalities and the justification of newly implemented policies. It is of great importance that students are able to deconstruct and/or reflect on these comparisons, in accordance with Vision II of scientific literacy and to attain Step 2 in the enhancement of

comparison competency (see Figure 6). Students as laypeople have to learn how scientific discourses are produced (Osborne, 2023; Osborne & Pimentel, 2022; Valladares, 2021). In order to evaluate the outcome of a comparison, it is necessary to consider the underlying rationale that led to the conclusion presented. This entails questioning the methodology employed by the individual responsible for the comparison, in order to ascertain how they were able to reach the final result. In order to evaluate the outcome of a comparison, it is essential to revisit the initial formulation of the distinct units, variables, questions, materials, and assess their relevance in addressing the initial question. Furthermore, the process of comparison itself can be subjected to scrutiny, as can the result and its implications. Additionally, the capacity of the individual undertaking the comparison to justify their own choices must be evaluated. In essence, the recipient of the comparison must be able to utilise the assessment tool (Simon & Budke, 2024b) to evaluate the quality of the comparison. A number of geographical actors formulate claims that require evaluation and deconstruction. Consequently, specific competencies required for receiving a comparison must be applied. A fruitful direction for research would be to focus on this particular aspect of the comparison competency. To this end, an adaptation and test of a specific adapted model of comparison competency (Simon & Budke, 2020), expanded with the model of argumentation competency towards the reception of an argument (Budke et al., 2010a; Kuckuck, 2014) may prove beneficial. It would also be interesting to investigate whether students perform better at evaluating a comparison than at producing it, as it is the case with argumentation competency (Kuckuck, 2014).

Finally, research in geography education could investigate methods for developing Step 3 of the enhancement of comparison competency, which encompasses the empowerment of students to engage in collective or political action as citizens through the use of geographical comparisons (see Figure 6). To understand how this would be possible, it would be necessary to combine action competency models (for example, Schönstein & Budke, 2024) with the competency model for comparison competency. Comparisons can be made at various stages of political or collective actions. They may be employed during the reflection phase, when geographical differences are analysed or debated, or during the diagnostic or decision phase, when arguments are made and decisions are taken regarding the measures or actions to be taken. A significant avenue for future research would be to examine the extent to which geographical comparisons can be utilised as arguments or as political or action tools.

With regard to research on comparisons in an international context, it is evident that further precision and investigation are required in order to address the various elements that have emerged from the discussion. The dissertation demonstrated that language-oriented

pedagogical tools have the potential to facilitate the development of comparison competency. Nevertheless, there may be significant discrepancies between countries with regard to this matter, and it would be essential to ascertain the extent to which such tools can be deemed valid and in which country. Firstly, the dissertation did not undertake a comparison of the text structures produced by German students with those produced by French students. However, there is a possibility that they may differ. French students are accustomed to practising the comparative *dissertation* and using the rhetorical device of comparison in this context. This practice is also evident in geography education. Conversely, German students do not frequently engage in such writing tasks in geography education, but they are accustomed to developing material-based arguments in upper secondary school (Budke, Gebele, et al., 2021). To what extent does this influence the quality of comparison texts they produce? Does it provide guidance on how to develop pedagogical tools to enhance comparison competency? Secondly, the linguistic requirements for structuring a comparison may vary between languages at the word, sentence or text level. To illustrate, at the word level, the German, English and French languages utilise comparable linguistic structures for expressing comparisons. These include suffixes such as -er, present in German (e.g. *breiter*, meaning “larger”), French (e.g. *meilleur*, meaning “best”) and in English (e.g. “larger”) (Rivara, 1995). However, the structures employed in argumentative texts may vary significantly across different languages. This is exemplified in scientific literature, where different writing styles and traditions are observed across countries (Siepmann, 2006). For example, English argumentative paragraphs frequently commence with a topic sentence or a claim. In contrast, French paragraphs either begin or end with the claim, while German paragraphs often conclude with the claim (Schröder, 1988). It would be interesting to ascertain whether the structure of paragraphs in student texts is also affected by these local differences. The question thus arises as to how this phenomenon manifests itself in the context of comparisons. To what extent is this related to comparison competency? In what ways would scaffolding need to be adapted at the local level in order to align with the distinctive morpho-syntactic or structural characteristics of each language? These different research questions could be explored in collaboration between language and geography didactics and could allow to specify the assessment tool for comparison competency while adapting it to local specificities, thus designing an effective international comparative assessment tool for comparison competency.

## **7. Conclusion: comparison competency as a new research field in geography education**

This dissertation was based on the premise that comparison is a fundamental aspect of understanding and acting in today's globalised world. Furthermore, it was built upon the idea that comparison is inextricably linked to the construction of knowledge and to argumentation. On the basis of these premises, the dissertation demonstrated the value of comparison as a cognitive tool, as a set of methods and means for constructing knowledge and thinking about geographical complexity, and also as an argumentative tool.

In light of the paucity of research in geography education on this fundamental tool, which should form an integral part of the pedagogical toolkit in geography lessons, the dissertation set out to define comparison competency, propose and test theoretical and educational tools, and provide initial empirical analyses of students' competency of comparison and ways of enhancing it. The dissertation itself employed international comparison as a means of developing and validating the aforementioned tools, applying the comparative approach to the subject matter itself.

In the sense of a geography education designed to foster competencies and help students develop their citizenship, comparison represents a multifaceted and interesting approach that is already present in current geography classes, but which necessitates a more comprehensive and structured enhancement and integration into the curriculum and teaching methods. Furthermore, embracing the potential and richness of comparison entails accepting the inherent complexity of comparison and the non-definitive nature of the answers to the questions posed by comparison, as well as its argumentative and linguistic dimensions. It is therefore incumbent upon geography educators and research in geography education to address further this challenge, in order to facilitate the development and practice of complex geographical competencies among students, contribute to their scientific literacy, and enhance their capacity to understand and act on complex geographical problems.

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## 9. Summary

The contemporary world is shaped by global processes such as climate change and globalisation, which exert varying influences on different regions. To comprehend the multiplicity of local manifestations of these global processes, the scientific discipline of geography employs the method of comparison as a means of constructing geographical knowledge. In this manner, comparison is also employed to elucidate disparities and, when appropriate, to establish a foundation for policies designed to mitigate them. Despite the recent emphasis on scientific methods and scientific literacy in science education policies, and despite the pervasiveness of comparison in school curricula, there has been no recognition of comparison as a complex geographical competency linked to argumentation that students should master. There is a paucity of theoretical approaches that conceptualise and evaluate comparison as a competency and method for teaching. Furthermore, there is a knowledge gap regarding the extent to which the comparison tasks in current geography textbooks facilitate the development of this competency and the extent to which students are competent. Additionally, there is a lack of research on the tools that can be used to reinforce this competency. In response to these research gaps, this cumulative dissertation offers initial insights by providing an international analysis of comparison competency using five research articles.

In the initial phase of the dissertation, an analysis of 20 geography textbooks containing 981 comparison tasks from England, Germany and France was conducted in order to ascertain the objectives of the comparison tasks and to propose a typology. Secondly, a competency model was developed to conceptualise comparison competency, and the comparison tasks were analysed to determine their capacity to reinforce this competency. The empirical results, based on the aforementioned theoretical models, indicate that the tasks found in geography textbooks often fail to reinforce this competency in all its dimensions.

In light of these findings, the second phase of the dissertation involved the development of a digital teaching unit and an assessment instrument for assessing comparison competency. The assessment tool was then field-tested and validated with a sample of 17 prospective geography teachers. The results of this assessment demonstrated that the students encountered challenges in the same dimensions of the competency model that were also problematic in the comparison tasks, particularly in the argumentative dimension of comparison competency.

Building on the findings of the development phase, the third phase of the dissertation employed a mixed-methods study utilising an intervention with 83 German and French secondary school students. This was implemented to assess students' initial comparison competency and to test

the efficacy of the comparison method as a tool for enhancing it. The intervention indicated that students in the experimental group exhibited a notable advancement between the pre-test and post-test and showed a correlation between the utilisation of the comparison method and their progression. In the qualitative phase of the intervention, the group discussions were subjected to analysis in order to reconstruct the students' orientations. The results demonstrated that the utilisation of the comparison method and participation in the discussions were associated with the students' progress during the intervention. However, the students encountered challenges when confronted with a task that did not necessitate a definitive response.

In the final discussion, it is demonstrated that the dissertation has shown that comparison is already present but an insufficiently reinforced competency in secondary education. Theoretical models and empirical results are interrelated and allow to define to what extent the dissertation contributed to provide approaches and tools to enhance comparison competency. Furthermore, the dissertation has enabled an initial comparative approach and international validation to possible pedagogical tools and scaffolds to promote this important competency, and proposes numerous directions for further exploration of this new field of research.

## 10. Zusammenfassung

Die heutige Welt ist geprägt von globalen Prozessen wie Klimawandel und Globalisierung. Diese üben unterschiedliche Einflüsse auf verschiedene geographische Räume aus. Die Methode des Vergleichs stellt ein wesentliches Instrument der Geographie zur Erfassung der Vielfalt lokaler Erscheinungsformen globaler Prozesse dar. Der Vergleich wird zudem eingesetzt, um Ungleichheiten aufzuzeigen und gegebenenfalls eine Grundlage für politische Maßnahmen zu deren Abmilderung zu schaffen. Obgleich in der internationalen Bildungspolitik eine jüngste Betonung wissenschaftlicher Methoden und wissenschaftlicher Kompetenz zu verzeichnen ist und der Vergleich eine Allgegenwart in den Curricula aufweist, wurde der Vergleich bislang nicht als komplexe geographische Kompetenz anerkannt, die mit Argumentation verbunden ist. Auch wurde bislang nicht festgestellt, dass diese Kompetenz von den Schüler:innen beherrscht werden sollte. Es fehlt an theoretischen Ansätzen, die den Vergleich als Kompetenz und Lehrmethode definieren und bewerten. Des Weiteren besteht eine Wissenslücke hinsichtlich der Fragestellung, inwiefern die Vergleichsaufgaben in den aktuellen Geographielehrbüchern die Entwicklung dieser Kompetenz fördern und inwiefern die Schüler:innen über die entsprechende Kompetenz verfügen. Zudem fehlen Untersuchungen zu den Instrumenten, die zur Förderung dieser Fähigkeit eingesetzt werden können. Als Antwort auf diese Forschungslücken präsentiert diese kumulative Dissertation erste Erkenntnisse, indem sie eine internationale Analyse und einen Vergleich dieser Kompetenz anhand von fünf Forschungsartikeln liefert.

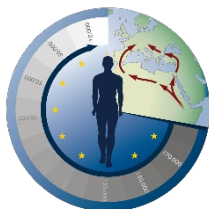
Im Rahmen der ersten Phase der Dissertation wurde eine Analyse von 20 Geographieschulbüchern mit insgesamt 981 Vergleichsaufgaben aus England, Deutschland und Frankreich durchgeführt. Ziel dieser Analyse war die Ermittlung der Ziele der Vergleichsaufgaben sowie die Entwicklung einer Typologie. In einem zweiten Schritt wurde ein Kompetenzmodell entwickelt, um die Vergleichskompetenz zu konzeptualisieren. Anschließend wurden die Vergleichsaufgaben analysiert, um ihre Fähigkeit zur Förderung dieser Kompetenz zu bestimmen. Die empirischen Ergebnisse, welche auf den zuvor dargelegten theoretischen Modellen basieren, legen nahe, dass die Aufgaben in Geographieschulbüchern diese Kompetenz häufig nicht in ihrer gesamten Bandbreite fördern. Auf Basis der gewonnenen Erkenntnisse wurde in der zweiten Phase der Dissertation eine digitale Lerneinheit sowie ein Instrument zur Bewertung der Vergleichskompetenz entwickelt. Das entwickelte Instrument wurde schließlich anhand einer Stichprobe von 17 angehenden Geographielehrkräften in der Praxis validiert. Die Resultate dieser Untersuchung

demonstrieren, dass die Studierenden in den identischen Dimensionen des Kompetenzmodells auf Schwierigkeiten stießen, die auch bei den Vergleichsaufgaben als problematisch erachtet wurden, insbesondere im Hinblick auf die argumentative Dimension der Vergleichskompetenz. Aufbauend auf den Ergebnissen der Entwicklungsphase wurde in der dritten Phase der Dissertation eine Interventionsstudie mit 83 deutschen und französischen Sekundarschüler:innen nach dem Mixed-Method-Ansatz durchgeführt. Diese wurde implementiert, um die Vergleichskompetenz der Schüler:innen zu beurteilen und die Wirksamkeit der Vergleichsmethode als Instrument zur Verbesserung dieser Kompetenz zu testen. Die Ergebnisse der Intervention belegen, dass die Schüler:innen der Experimentalgruppe zwischen dem Vortest und dem Nachtest signifikante Fortschritte aufwiesen, die mit der Anwendung der Vergleichsmethode korrelieren. Im Rahmen der nachfolgenden qualitativen Studie erfolgte eine Analyse der Gruppendiskussionen während der Intervention, um die Orientierungen der Schüler:innen zu rekonstruieren. Die Resultate legen nahe, dass die Anwendung der Vergleichsmethode und die Teilnahme an den Diskussionen mit den Fortschritten der Schüler:innen während der Intervention korrelierten. Die Schüler:innen hatten jedoch Schwierigkeiten, wenn sie mit einer Aufgabe konfrontiert wurden, die keine endgültige Antwort erforderte.

In der abschließenden Diskussion wird dargelegt, dass die Dissertation aufgezeigt hat, dass das Vergleichen bereits vorhanden ist, jedoch eine unzureichend gefestigte Kompetenz in der Sekundarstufe darstellt. Theoretische Modelle und empirische Ergebnisse sind miteinander verknüpft und lassen erkennen, inwieweit die Dissertation dazu beiträgt, Ansätze und Instrumente zur Verbesserung der Vergleichskompetenz bereitzustellen. Des Weiteren ermöglicht die Dissertation einen ersten vergleichenden Ansatz sowie eine internationale Validierung potenzieller Fördermaßnahmen zur Stärkung dieser bedeutsamen Kompetenz. Zudem werden vielversprechende Ansätze für die weitere Erforschung dieses neuen Forschungsgebiets aufgezeigt.

## 11. Appendix

### 11.1 Appendix 1: How to compare? Task sheet from the digital learning unit



SFB 806 – Our Way to Europe



**Arguing when comparing using the example of migrations**

#### 2. How to compare?

**The comparison method using the example of migrations**

Document source: <https://youtu.be/w7vjRjAm2Rw>

**The steps while comparing:**

#### 1. Ask a *question*: Are the stories of the two people similar?

Task: Explain why the UNICEF organisation asked this question.

Tip: Research what [UNICEF](#)'s tasks are.

#### 2. Select *comparison units*: the stories of Harry and Ahmed.

Task: Explain why the different historical contexts of [Harry and Ahmed's stories](#) can be interesting.

#### 3. Select *comparison variables*

Reminder: We have already worked on the variables. What were they again? Tick the variables that are used to compare the two stories in the video (multiple answers).

Variables	In the video?
Economic situation	
Emotions	
Climate	
Dangers	
Age	

#### 4. *Juxtapose* comparison units and comparison variables (e.g. in a table):

Task: copy the elements in the table: "An old man who fled as a child", "Political: fleeing the war", "They both fled as children, but at different times", "A boy", "Political: fleeing the pogroms", "Both emigrated for political reasons and were then refugees".

Variables	Harry	Ahmed	To what extent is the variable interesting for the comparison?
Age			
Reason for fleeing			

**5. Weighting of the variables. Thus, explanations and rules are also found.**

Examples:

"The variable "country of origin" is more interesting for a comparison of the two life stories than the variable "language", as the political backgrounds of the countries better explain the reasons for the migration of the two people."

"It is also all the more interesting in the current context where Germany is now a country of destination rather than a country of origin."

"The variable "emotions" is interesting because it shows that migrants or refugees experience many difficulties and difficult feelings."

Complete the task in the Excel table "How to compare"

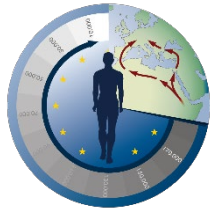
**6. At the end, answer the question.**

The question of the video was: "Are the stories of the two people similar?" Answer the question by evaluating the comparison made in the video and justifying your opinion. Use the Word file to write a short text (max. 10 lines).



Comparison means selecting and weighting elements. Therefore, there is no **good answer**: at each step you have to justify and justify your choices!

## 11.2 Appendix 2: Putting it into practice. Task sheet from the digital learning unit.



SFB 806 – Our Way to Europe



Arguing when comparing using the example of migrations

### 3. Putting it into practice: Instructions

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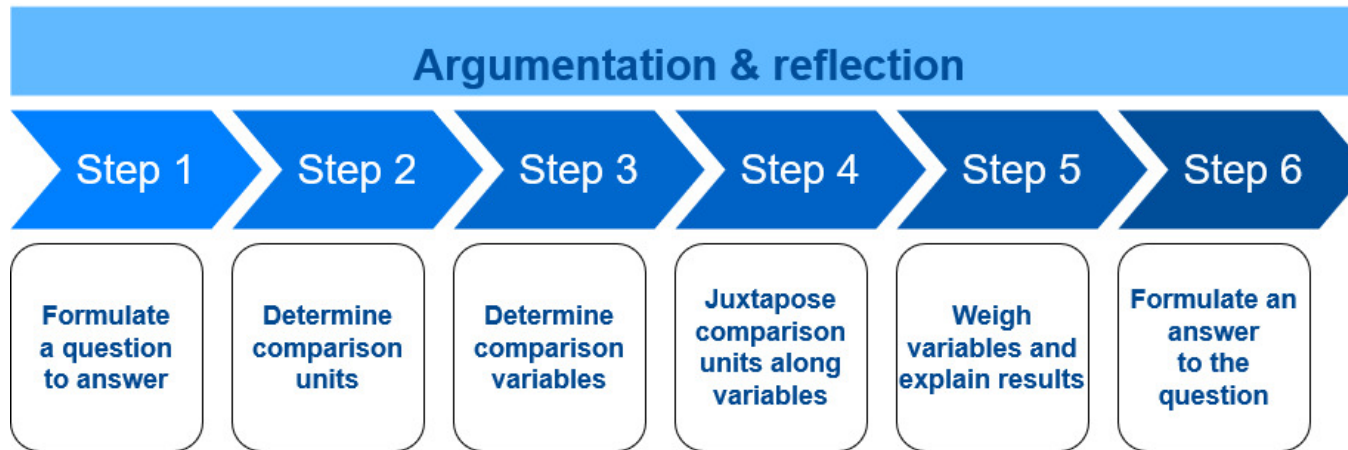
**Read all the instructions carefully before starting.**

The following documents come from the research of scientists working on current and past migrations. In the case of Homo Sapiens migration, these researchers belong to the Collaborative Research Centre CRC-806.

In these pages, you will use the comparative method you developed in the “how to compare” chapter. To do this, you will, as you learned in the method :

- Step 1: formulate a question to answer
- Step 2: determine comparison units
- Step 3: determine comparison variables
- Step 4: juxtapose comparison units according to the variables
- Step 5: Weigh the variables, explain the results
- Step 6: formulate an answer to the question.





### Step 1: formulate a question to answer

Your objective: to compare migrations.

1. **Choose a question that you would like to work on using the documents on the following pages. To help you make your choice, the issues have been classified in order of difficulty:**

\* Easy level

\*\*Medium level

\*\*\* Difficult level

\*Question 1 - What do the factors explaining past migrations have in common with those explaining current migrations?

\*\*Question 2 - To what extent are the obstacles encountered during past and current migrations similar?

\*\*\*Question 3 - How do the ancient migration routes used by Homo Sapiens outside Africa differ from those used today?

\*\*\*Question 4 - How do the sources used for research on ancient migrations differ from those used for current migrations?

\*\*\*OPTIONAL: Formulate your own question based on the documents on the pages (4. DOCUMENTS). This problem should propose a comparison between past and present migration.

Remember: a question guides your thinking and presents the problem you wish to solve. It may begin with “Why”, “How”, “To what extent”, etc.

**2. To answer your question, you now need to consult different documents on different pages. Work on these documents and the accompanying tasks. To do this, click on the links below that correspond to your question.**

### Steps 2 and 3: Determine the units of comparison and variables

Complete the table below

- with the question you have selected
- using the documents and tasks provided on page 4. DOCUMENTS.

<b>Step 1</b>	Question	<i>(E.g.: Are the reasons for migration similar??)</i>		
<b>Step 2</b>		Unit n°1	Unit n°2	Unit n°3
	Comparison units (=What are we comparing?)	<i>(E.g.: the North-West Africa route today and in the past)</i>		

	Justification for the choice of units			
<b>Step 3</b>		Variable n°1	Variable n°2	Variable n°3
	Variables used for the comparison (= what criteria do we use to compare?)	<i>(e.g. sources used or means of transport)</i>		
	Justification for the choice of variables			
		1st document used	2nd document used	3rd document used
	Documents used for the comparison	<i>(e.g. chronology, climate map of Africa)</i>		
	Justification for the choice of documents			

Complete the tasks suggested on the pages corresponding to your question.

Take notes:

**Steps 4 and 5: juxtapose the units according to the variables, weigh the variables and explain.**

Complete the table below based on your analysis.

Insert columns or rows to obtain the desired number of variables or units.

			<b>Step 4:</b> <b>Juxtapose comparison units according to the variables</b>				<b>Step 5: Weigh the variables and explain results</b>		
Variable	Unit 1	Unit 2	Are the units similar or different? Tick the appropriate box:				Justify your results	Why is this variable relevant to your results?	Variable weighting (1: most important variable, 2: 2nd most important variable, etc.) Only fill in this column when you have finished entering all
			<i>Very similar</i>	<i>Similar</i>	<i>Different</i>	<i>Very different</i>			

									the variables used in the table.
<i>E.g.: factors for migration</i>	<i>E.g.: migration today</i>	<i>E.g.: past migrations</i>							

Evaluate the variables according to the response they provide to your problem (right-hand column)

Justify your assessment (below)

---



---

### 11.3 Appendix 3: Task sheet from group discussions (Phase 1)

PHASE 1

Question: “To what extent are the reasons for migration similar in the past and today?”



**Discuss in the group by asking and answering the following questions!**

- What answers did each of you give to your question?
- Are the group members' answers similar or different?



**Discuss further: Find out why the answers of the group members are similar/different!**

**You can use these questions as a guide:**

- Did you choose the same units?
- Did you choose the same variables?
- Did you choose the same materials?
- Have you weighted the variables equally?
- Are there any other possible reasons you can think of that explain the differences/similarities?



**Agree on a joint result in which you give a common answer to the question you have chosen!**

<b>OPTION 1</b>	<b>OPTION 2</b>
If your results and your answer to the question are <b>similar</b>	If your results and your answer to the question are <b>different</b>
<ul style="list-style-type: none"> <li>- Formulate this answer precisely and accurately!</li> <li>- Justify your answer by indicating the conditions under which it is valid, i.e. in relation to which units, which variables,</li> </ul>	<ul style="list-style-type: none"> <li>- Find an agreement and give a common answer!</li> <li>- Justify your answer! Then state the conditions under which this agreement is valid, i.e. for which units, which variables, which material, etc.!</li> </ul>



## 11.4 Appendix 4: Task sheet from group discussions (Phase 2)

### PHASE 2

**Present the results** from the first group discussion:

1

- **Present the question and the common results** / common answer of the group.
  - **Precise the conditions** under which these results are valid.
- 

2

**Debate** in the group to find a **common answer** to the overarching question:

"Are migration movements in the past and today similar or different?"

**Steps:**

a

**Choose a statement:** "Migration movements in the past and today are similar / different".

Or: **formulate a different statement** that answers the question.

b

**Build arguments to support your statement (= your assertion).**

*Following formulations can **help** you to do this:*

- *"This result becomes clear if you consider the following question(s): "*
- *"This question/topic (reasons/obstacles/routes/research/....) appear to be the most important one(s), because...."*
- *"Under this/these question(s), we can then conclude that migration movements are similar/different because...."*
- *"Here, the following variable(s) (.....) seem to be the most important, because...."*
- *"Other variables (.....) appear to be less important, because...."*
- *"To support our claim, we consider following materials to be most important: ....., since....."*

**All your answers must be justified and argued.**

3

**Prepare a poster** with your key statements presenting the claim and arguments.



## 12. Own participation in the five publications

### Study 1:

**Title:** The objectives and uses of comparisons in geography textbooks: Results of an international comparative analysis

**Authors:** Marine Simon, Alexandra Budke and Frank Schäbitz

**Status:** Published

**Journal:** Heliyon

**Year:** 2020

**Issue:** 6(8)

**Pages:** 1-13

**Available online:** <https://doi.org/10.1016/j.heliyon.2020.e04420>

**Own contribution:** Conceptualisation; Data curation; Formal analysis; Investigation; Methodology; Visualisation; Writing – original draft; Writing – review & editing.

### Study 2:

**Title:** How Geography Textbook Tasks Promote Comparison Competency - An International Analysis

**Authors:** Marine Simon and Alexandra Budke

**Status:** Published

**Journal:** Sustainability

**Year:** 2020

**Issue:** 12(20)

**Pages:** 8344

**Available online:** <https://doi.org/10.3390/su12208344>

**Own contribution:** Conceptualisation; Data curation; Formal analysis; Investigation; Methodology; Visualisation; Writing – original draft; Writing – review & editing.

### Study 3:

**Title:** Students' comparison competencies in geography: Results from an explorative assessment study

**Authors:** Marine Simon and Alexandra Budke

**Status:** Published

**Journal:** Journal of Geography in Higher Education

**Year:** 2024 (in 2023 online)

**Issue:** 48(1)

**Pages:** 94-114

**Available online:** <https://doi.org/10.3390/su12208344>

**Own contribution:** Conceptualisation; Data curation; Formal analysis; Investigation; Methodology; Visualisation; Writing – original draft; Writing – review & editing.

**Study 4:**

**Title:** An intervention study: Teaching the comparison method to enhance secondary students' comparison competency

**Authors:** Marine Simon and Alexandra Budke

**Status:** Published

**Journal:** International Research in Geographical and Environmental Education

**Year:** 2024 (in 2023 online)

**Issue:** 33(1)

**Pages:** 72-89

**Available online:** <https://doi.org/10.1080/10382046.2023.2214039>

**Own contribution:** Conceptualisation; Data curation; Formal analysis; Investigation; Methodology; Visualisation; Writing – original draft; Writing – review & editing.

**Study 5:**

**Title:** German and French Students' Strategies While Performing Geographical Comparisons in a Group Task Setting

**Authors:** Marine Simon and Alexandra Budke

**Status:** Published

**Journal:** Education Sciences

**Year:** 2023

**Issue:** 13(8)

**Pages:** 849

**Available online:** <https://doi.org/10.3390/educsci13080849>

**Own contribution:** Conceptualisation; Data curation; Formal analysis; Investigation; Methodology; Visualisation; Writing – original draft; Writing – review & editing.

### **13. Erklärung gemäß § 7 Absatz 8**

Hiermit versichere ich an Eides statt, dass ich die vorliegende Dissertation selbstständig und ohne die Benutzung anderer als der angegebenen Hilfsmittel und Literatur angefertigt habe. Alle Stellen, die wörtlich oder sinngemäß aus veröffentlichten und nicht veröffentlichten Werken dem Wortlaut oder dem Sinn nach entnommen wurden, sind als solche kenntlich gemacht. Ich versichere an Eides statt, dass diese Dissertation noch keiner anderen Fakultät oder Universität zur Prüfung vorgelegen hat; dass sie - abgesehen von unten angegebenen Teilpublikationen und eingebundenen Artikeln und Manuskripten - noch nicht veröffentlicht worden ist sowie, dass ich eine Veröffentlichung der Dissertation vor Abschluss der Promotion nicht ohne Genehmigung des Promotionsausschusses vornehmen werde. Die Bestimmungen dieser Ordnung sind mir bekannt. Darüber hinaus erkläre ich hiermit, dass ich die Ordnung zur Sicherung guter wissenschaftlicher Praxis und zum Umgang mit wissenschaftlichem Fehlverhalten der Universität zu Köln gelesen und sie bei der Durchführung der Dissertation zugrundeliegenden Arbeiten und der schriftlich verfassten Dissertation beachtet habe und verpflichte mich hiermit, die dort genannten Vorgaben bei allen wissenschaftlichen Tätigkeiten zu beachten und umzusetzen. Ich versichere, dass die eingereichte elektronische Fassung der eingereichten Druckfassung vollständig entspricht.

Köln, 21.7.2024